DOE/MC/31175 -- 5230
(DE96011332)

# Treatment of Metal-Laden Hazardous Wastes with Advanced Clean Coal Technology By-Products

## Quarterly Report
## February - May 1995



July 1995

Work Performed Under Contract No.: DE-FC21-94MC31175

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

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# EXECUTIVE SUMMARY

During the third quarter, six by-product samples for Phase One and one large by-product sample (the pressurized fluid-bed combustion cyclone ash) for Phase Two were collected. By the conclusion of the third quarter the great majority of the analysis of the Phase One by-product samples had been accomplished. Efforts are still underway to identify a fourth by-product for the project. The six hazardous wastes, which had been identified as suitable for the project, were treated at the laboratory scale with the three by-products (at three treatment levels) which have been provided for the project to date. Analyses of leachates of the product of 45 of these 54 treatments have been completed and decisions will be made early in the fourth quarter concerning which 15 of these treatments will be evaluated for solidification. Several additional background documents have been located. A news brief has been published describing the project in the Pitt Engineering Monthly News Brief. The first of two undergraduate summer students has begun work on the project.

## By-Products

Dravo Lime Company (DLC) collected two samples from CONSOL, one from Ebensburg Power Company (EPC) and three from the Tidd Station. The attempt to obtain permission to use the AES Thames by-product have ceased and discussions are underway with the midwestern office of JTM Industries (JTM) to obtain a fourth by-product from one of their clients.

A fifty-ton sample of by-product from the Tidd Station was collected February 21, 1995. It was transferred at Aimcor in Aurora, Indiana, to 50 super-sacks and stored at DLC.

## Hazardous Wastes

MSI and Pitt have completed the analysis of the six hazardous wastes that were determined previously to be suitable for the project. MSI has treated all of them at three levels with the three by-products. Toxicity Characteristic Leaching Procedure (TCLP) extracts have been obtained for all 54 of these products.

The CONSOL by-product has been found to be a very effective treatment chemical. The EPC by-product was the least effective, while the Tidd by-product was more effective than that from EPC, but still not sufficient to be considered of commercial interest to MSI. None of the by-products were particularly successful in stabilizing the wastes generated by high temperature processes (BOF dust, municipal incinerator ash).

The EPC by-product was found to be very alkaline.

The project team is discussing the possible use of additives to improve the performance of the EPC and Tidd by-products for use commercially by MSI for rapid stabilization and landfilling of the product. It is also exploring the possibility of examining the long-term stabilization performance of these two by-products with the suggestion to consider their beneficial use in structural fills, mortars and grouts. A modification to the Test Plan will be proposed to redirect some of the effort in Phase One in this direction.

## General Considerations

The structure of the database has been determined and construction of the database has begun. Tables presented in the appendices of this report were prepared using the Quatropro program, in which the database is housed.

Two additional papers and three transmissions from the internet have been added to the literature survey of the project. The files of MSI have been utilized to develop background sketches on the six wastes already treated on the project.

Three public reports on the project have been provided through Morgantown Energy Technology Center's (METC's) Technology Status Report, through a compilation of letters describing U.S.DOE-sponsored projects which was presented to the House Appropriations Interior Subcommittee by Assistant Secretary for Fossil Energy Patricia Godley, and through an article in the April 1995 issue of the Pitt Engineering Monthly News Brief.

An undergraduate summer student began full-time work on the project in mid-May and a second undergraduate researcher will begin a ten-week program of study in the first few days of June. The second student will be assigned to the project from the Research Experience for Undergraduates program, sponsored by the National Science Foundation and operated in the Pitt Engineering School by the Chemical and Petroleum Engineering Department.

## Plans for the Next Quarter

During the fourth quarter of Phase One the strands of activities being carried out during this phase will be drawn together. Most are called for in the Test Plan dated October 17, 1994, but several will be conducted in accordance with modifications to the Test Plan which will be proposed early in the fourth quarter.

Identification of the fourth by-product will continue to be pursued. Analyses of all by-product samples for Phase One will be completed.

An additional four suitable wastes for treatment will be sought. Solidification tests will be initiated for the best of each of the eighteen waste/by-product sets defined by the laboratory treatments already conducted.

The economic evaluation of treatments that appear to be commercially useful - technically - to MSI will be conducted. The literature survey and the collection of background information will be concluded. The assessment of environmental impacts of Phase Two will be carried out. Work will begin on the Topical Report describing Phase One.

# INTRODUCTION

This third quarterly report describes work done during the third three months of the University of Pittsburgh's (Pitt's) project on the "Treatment of Metal-Laden Hazardous Wastes with Advanced Clean Coal Technology By-Products."

Participating with Pitt on this project are Dravo Lime Company (DLC), Mill Service, Inc. (MSI) and the Center for Hazardous Materials Research (CHMR).

This report describes the activities of the project team during the reporting period. The principal work has focussed upon the laboratory treatment of six wastes with three by-products and the evaluation of the stability of the resulting eighteen materials. Other efforts during the third quarter have been directed toward completion of the collection and analysis of by-products, the identification of a suitable fourth by-product, and the definition of the approach to the solidification tests.

The activity on the project during the third quarter of Phase One, as presented in the following sections, has fallen into three major areas:

- Acquiring and analyzing by-products
- Treating hazardous wastes with by-products in the laboratory and analyzing the results
- Conducting administrative activities, including public relations and personnel additions.

# BY-PRODUCTS

By-Product Acquisition

All but two of the thirty samples of approved by-products, as well as ten samples of the AES Thames by-product, have been collected during the first three quarters. A record of all of these samples is given in Appendix A. Here is a synopsis of the activity of the third quarter.

Carneys Point Cogeneration Plant. Two samples (#7 and #8) of the spray drier fly ash were collected at CONSOL's Blacksville receiving terminal near Waynesburg, Pennsylvania. Car numbers of the covered hopper rail cars and dates loaded were recorded. The daily boiler operating reports for the time periods of ash samples have not yet been received. The ninth and tenth samples will be collected during the fourth quarter.

Ebensburg Power Company. The final, tenth dry sample was collected from the storage silo for the characterization program. The silo sample is a blend of bed ash and cyclone ash.

Tidd Station. The final three samples (#8, #9 and #10) from the dry cyclone ash silo were collected. The silo has a one-day capacity when the unit is operating at its full rating. The ash from the silo also includes the electrostatic precipitator ash. Daily operating reports on boiler conditions for each sample time period will be sought during the fourth quarter.

AES Thames River Plant. All ten of the required samples had been collected at Anker Energy's Albright (WV) receiving station. Car numbers and loading dates were recorded. Daily operating reports for the time period of ash samples loaded into the cars will be sought during the fourth quarter.

In the third quarter discussions continued with AES Thames, ERL, JTM Industries' eastern office, DLC, MSI and Morgantown Energy Technology Center (METC) (see Appendix I). In nearly a dozen-and-a-half conversations, the following points have emerged regarding the availability of CCT by-products for treatment of hazardous wastes.

1. The by-product producer must approve all disposition of by-product.

2. The by-product producer requires indemnification from the direct recipient of the by-product.

3. The by-product producer prefers to maintain confidentiality of properties of the by-product and the fact of being its source when it is used to treat hazardous waste.

4. The by-product producer retains control over the by-product by contract with the owner of the ultimate repository of the by-product.

5. The direct recipient of the by-product must have sufficient cash flow by by-product sales to cover the cost of providing indemnification.

6. The manager of the by-product may enter substantively into a portion of transporting and disposing the by-product.

7. The purchase of by-product by a hazardous waste treatment facility is a private transaction. The public manifest for hazardous waste does not include the source of the treatment chemical. The treatment chemical may be marketed and provided privately by a distributor, who may not formally identify the by-product producer to the treater.

During these discussions, the project team also learned that staff at the Edison Electric Institute and the University of North Dakota Energy Research Center are assisting in preparing ASTM[1] standards for treating hazardous wastes with by-products. There is an indication that federal legislation may be needed to limit liability in regard to by-product use in treating Superfund sites.

When it finally became clear that these discussions were not leading to approval to use the AES Thames by-product, they were abandoned. Discussions were then opened with the midwestern office of JTM, through which it is hoped that an alternate coal-fired fluid-bed combustor by-product may be obtained. These discussions continue, although there still appears to be a problem with indemnification, as well as with public presentation of by-product property information. However, the project team has a strong expectation that these problems will be overcome by the staff of JTM's midwestern office.

On the chance that they are not overcome, several alternatives are being considered. One is another coal-fired FBC by-product suggested by DLC. There are two reasons that a coal-fired FBC by-product is desired as the fourth by-product. One is that this type of material is currently being used commercially to treat hazardous waste and would therefore serve as a baseline for the other by-products in this study. The other is the interesting features which DLC has found in the AES Thames by-product, which leads DLC to believe that it would be a more effective treatment chemical than the coal waste-fired FBC by-product or the PFBC by-product.

<u>Phase Two Sample</u>. The PFBC at the Tidd Station was permanently shutdown in early spring 1995. Therefore, in late February the project team collected the 50-ton sample of this by-product, which will be needed for Phase Two.

The initial thought as to how this sample could be collected was to install a new fill nozzle on the cyclone ash silo to connect to super-sacks. However, the material in the silo is kept at 300-400°F to assure that no moisture will condense on the ash, which could lead to plugging. The super-sacks cannot tolerate temperatures this high. Therefore it was decided to use the existing elephant trunk to transfer the hot ash to pneumatic tanker trucks, provided by Bulk Transit Company.

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[1] American Society for Testing and Materials

Several approaches were considered for transferring the by-product from the tanker trucks to the super-sacks. Two that were discarded were (1) direct filling at the Cardinal Station's disposal site (where the Tidd ash was also being disposed) and (2) staged filling from a second silo. The first discarded approach was deemed insufficiently robust and a potential dust emission source too difficult to control. The second failed for lack of an easily obtained suitable silo.

The approach that was finally used involved travel of the tanker trucks to a commercial bagger, Aimcor in Aurora, Indiana, which has the capability of removing the ash from the tanker trucks, cooling it, filling approximately 50 super-sacks and placing them on pallets for transport back to DLC in Pittsburgh for storage.

DLC cleared a portion of a building at their Research Center where the super-sacks have been stored until they can all be shipped to MSI in late 1995 or early 1996.

## By-Product Analysis

### Analysis by Dravo Lime Company

During the third quarter, eighteen additional samples were worked on. Seven samples out of 40 being processed remain incomplete. This includes one sample (CONSOL #10) that still remains to be collected as this report is written.

Three samples on each of the four FGD sources were analyzed for BET specific surface area (SSA) ($m^2/g$) and Microtrac particle size distribution (PSD) parameters. These data are reported along with the other physical properties. PSD analysis can only be done on material passing the #80 mesh sieve. More detail is available upon request. Some of the samples reported in the second quarterly report were tested for SSA and PSD. The results of all by-product analyses, conducted at DLC during both the second and third quarters, are shown in Appendix B.

Those samples yet incomplete are being rechecked for accuracy and precision. Some difficulty has been experienced getting them fused into solution. As of this report date most discrepancies and analytical procedure problems have been resolved on the six incomplete samples.

A thorough discussion of sample characterization and analysis will be included in the fourth quarter report at which time all data analyses will be complete and summarized.

### Analysis by Mill Service, Inc.

No additional analyses of by-products were performed by MSI during the third quarter.

### Analysis by the University of Pittsburgh

During the third quarter, Pitt analyzed the four additional metals (Sb, Be, Th and V) in the four by-products, which had been analyzed by MSI during the second quarter. In addition

Pitt carried out nine extractions of other byproduct samples and began the complete analysis of the extracts.

Six by-product samples (AES # 2, 4, and 7, CONSOL # 1, EPC # 2, 3, 4 and 5, and Tidd # 2) were extracted by the ASTM protocol and five by-product samples (AES # 2 and 7 and EPC # 2, 4 and 5) were extracted by the Toxicity Characteristic Leaching Protocol (TCLP). Extracts of four of the same samples (AES # 4, CONSOL # 1, EPC # 3 and Tidd # 2), obtained using the TCLP protocol, were received from MSI. The analyses of all of the extracts from both the second and third quarters by MSI and Pitt are shown in Appendix C.

# HAZARDOUS WASTES

## Analysis of Hazardous Wastes

The analysis of six suitable metal-laden hazardous wastes were completed in the third quarter and the results from both the second and third quarters are tabulated in Appendix D.[2] Each of the wastes contains some metals at concentrations greater than or equal to 20 times the toxicity characteristic limits or greater than or equal to 20 times the Land Disposal Restriction (LDR) treatment standards. Metal concentrations at these levels in the wastes are of concern due to the potential that they will leach under the altered conditions present in the treated waste samples generated during the waste treatment portion of this project. The parameters of concern in each of the wastes are:

- Industrial Wastewater Treatment Residue from Battery Manufacturing Plant
  Cd, Pb, Sb

- Contaminated Soil from a Remediation Project Conducted at a Munitions Depot
  Ba, Cd, Cr, Pb, Zn, Be, V

- Contaminated Soil from a Remediation Project Conducted at an Abandoned Industrial Site
  Ba, Cd, Cr, Pb, Hg, Zn, Be, V

- Contaminated Soil from a Remediation Project Conducted at a Former Sewage Treatment Plant
  Pb, Zn

- Air Pollution Control Dust from Basic Oxygen Furnace Steel Production
  Cd, Cr, Pb, Ni, Zn, V

- Air Pollution Control Ash from Municipal Waste Incineration
  As, Ba, Cd, Cr, Pb, Hg, Ni, Se, Ag, Zn, Sb, Be, V

## Treatment of Suitable Hazardous Wastes

The characteristic metal-laden hazardous wastes determined to be suitable were each treated at MSI during the third quarter with the three approved by-products at weight ratios of 1:10, 3:10 and 1:10 (by-product:waste). A small quantity of water was used in most of the treatments. All of the treatments were conducted in the Yukon facility laboratory using 200-gram aliquots of waste in each treatment. Following the completion of the treatment batch, a 100-gram portion of the waste/by-product mixture was removed and extracted according to the TCLP protocol. The extract generated was then distributed into two 1-liter

[2] Other waste samples collected for use in the project have failed to meet the use criteria (did not exhibit the expected hazardous waste characteristics).

sample bottles and preserved with nitric acid for subsequent analysis. This procedure was repeated for each of the waste/by-product mixtures 24 hours after the completion of the treatment batch.

One of each of the extract samples was then delivered to Antech, Ltd. for analysis to determine (1) if the waste/by-product mixture continued to exhibit the hazardous waste characteristic(s) exhibited by the untreated waste, (2) if the waste/by-product mixture exhibited any other hazardous waste characteristics based on the parameters of concern identified from the total metals analyses performed on the waste and by-product as defined in the preceding section, and (3) if the waste/by-product mixture achieved the LDR treatment standards. For this third determination, the residues were analyzed for the parameters in the table shown in Appendix E. The review leading to this table compared the results of waste and by-product analyses against projected future LDR treatment standards. As a safety factor, 80% of the LDR level was assumed as the cutoff for testing.

Analytical request forms accompanied the samples to Antech. The forms identified the parameters to be analyzed, the analytical methods to be used, and the detection levels to be achieved. The extract samples prepared for Pitt were also delivered.

## Results to Date

The results of the analyses of the forty-five extracts are given in Appendix F. The results have been evaluated by MSI. The following comments from MSI are based on the use of the by-products as a stabilization (not solidification) agent under conditions that are similar to those employed at MSI's TSD facility on a daily basis. In evaluating the data, the treatment residue TCLP results were compared against the current disposal criteria (TC limits) as well as the anticipated future limits (LDR UTS). The potential that the treatment achieved could be attributed to dilution was also evaluated.

- The EPC #3 by-product is not an effective waste stabilization agent. The use of this by-product generated a treatment residue that could be land disposed under today's standards in only 1 of the 15 treatability tests attempted.[3] The successful treatment occurred in the munitions depot soil at the highest by-product dosage tested after the material was allowed to "age" for 24 hours. The use of this by-product did not generate a treatment residue that could be land disposed under the projected future standards in any of the attempted treatments.

- The Tidd #2 by-product was generally more effective than the EPC #3 by-product but MSI's overall evaluation is that it is not an effective waste stabilization agent either. The use of this by-product generated a treatment residue that could be land disposed

[3] A second test also appeared to be successful (multi-use industrial site soil at highest by-product dosage); however, the extraction performed after the treatment residue aged for 24 hours failed to confirm the initial result.

under today's standards in only 2 of the 15 treatability tests attempted.[4] The successful treatments occurred in the munitions depot soil and the multi-use industrial site soil at the highest by-product dosage tested in both cases. The results of the fresh and aged materials were comparable. Both meet today's land disposal standards. The use of this by-product generated a treatment residue that could be land disposed under the projected future standards in only 1 of the 15 treatability tests attempted (munitions depot soil at highest by-product dosage).

- The CONSOL #1 by-product was the most effective of the three by-products tested and MSI would consider it to be an effective waste stabilization agent when used in combination with certain types of wastes. The use of this by-product generated a treatment residue that could be land disposed under today's standards in 10 of the 15 treatability tests attempted.[5] The successful treatments occurred in the battery manufacturing sludge, munitions depot soil and the multi-use industrial site soil at all of the by-product dosages tested and in the BOF dust at the highest dosage tested (after aging). The results of the fresh and aged materials were comparable. Both meet today's land disposal standards. The use of this by-product was less successful in generating a treatment residue that could be land disposed under the projected future standards. Only 4 of the 15 treatability tests attempted (battery manufacturing sludge/all by-product dosages, munitions depot soil/highest by-product dosage) achieved the future standards. The success of the CONSOL by-product is such that MSI will soon be calculating the value that MSI would place upon the CONSOL by-product (be it positive or negative), FOB the Yukon Plant, if it were used in the best recipe found to date.

- None of the by-products were particularly successful in stabilizing the wastes generated by high temperature processes (BOF dust, municipal incinerator ash). MSI assumes this may be due to the form of the metals present in these wastes (likely present as oxides that leach but do not readily chemically combine with the constituents available in the by-products).

- Overall, there was little difference in the results achieved in the treatment residues analyzed immediately after treatment and in the residues analyzed after a 24-hour aging period.

- The EPC #3 by-product does not appear to offer much buffering capacity based on the fact that Extraction Fluid #1 was used in most of the TCLP extractions.

[4] As with the EPC #3 by-product, the Tidd #2 by-product produced a treatment residue when combined with a third waste (battery manufacturer sludge at highest by-product dosage) that also appeared to be successful based on the initial analysis; however, the extraction performed after the treatment residue aged for 24 hours failed to confirm the initial result.

[5] As with the other by-products, the CONSOL #1 by-product produced one treatment residue (BOF dust at lowest by-product dosage) that also appeared to be successful based on the initial analysis; however, the extraction performed after the treatment residue aged for 24 hours failed to confirm the initial result.

- None of the successful treatments achieved could be attributed solely to dilution. Thus, the success of the treatments may be directly attributed to encapsulation/stabilization or reduction in permeability cased by the by-products as treatment chemicals.

At this point in the project, the project team has begun discussing additives that are sometimes used by MSI and the other waste treaters. The principal type of additive is one containing the phosphate ion, although commercial sources of the phosphate ion contain silicates which are also known to participate significantly in metal stabilization. The value of the phosphate ion is well-known in the literature, including in Conner's book.

The project team is also considering the also well-known slower rate at which portland cement-based stabilizers (and by inference pozzolanic stabilizers) tie up hazardous wastes than do lime-based stabilizers. Unfortunately, commercial treaters such as MSI cannot economically utilize such slow stabilizers under their existing temporary storage permits, which limit the amount of space in which treated wastes may be held while awaiting clearance from TCLP tests for transfer to landfill.

However, a different commercial scenario is conceivable in which a slowly (but surely) stabilized waste is placed in a monitored structural fill. Such a placement would likely be made using a treated product having soil-like properties (lower water content), rather than slurry properties (higher water content) such as are used to pour (trowel) as mortar (with or without coarse aggregate) into concrete forms or to pump as grout into cavities. Under this new scenario, the solidification characteristics of the soil-like material become important. Because these characteristics are best determined through the Proctor Test, rather than the typical mortar test, the project team is preparing a request to modify the test plan to evaluate long-term stabilization and to shift to Proctor Testing for those waste/by-product mixtures which are stabilized only in the long-term.

# GENERAL CONSIDERATIONS

Laboratory Work at Pitt

A number of special observations have been made and situations encountered at Pitt during this quarter.

- The TCLP extracts of by-products are very alkaline, even though the stronger extraction fluid was used (based upon testing before extraction). The spiked samples before extraction are not returning the added metals because of this alkalinity. When spiked samples of the acidified extract are prepared, the added metals remain in solution.

- Antimony, thallium and vanadium standards proved difficult to prepare. Therefore, standard solutions of these three metals were purchased.

- Lamps for the atomic absorption detector frequently need to be replaced. Both the silver and thallium lamps were replaced during this quarter.

- Particular attention is being paid to detection limits. In order of increasing sensitivity are ICP, flame AA and graphite furnace AA. There are two detection limits - (1) the absolute one based upon the lowest observable signal from the instrument and (2) the instrumental one based upon the lowest calibration value. For this project it was determined that ICP was sufficient for most metal analyses, but that the four additional metals would have to be measured by graphite furnace AA and certain by-product metals would be measured by flame AA, which is the standard method at Pitt. The detection limit can vary for a given metal as a function of interferences ("chemical noise") from other components in the sample.

- The Quatropro database for all laboratory results (including those from DLC and MSI) has been discussed extensively. Work on its development has begun. It is expected to be a large (2 MEG) file. Using Quatropro will allow numerous subfiles and templates to be developed to produce graphical displays for evaluation. The graphical displays will likely be three-dimensional bar charts.

Background Development

The files of MSI have been utilized to develop background sketches on the six hazardous wastes that have been determined to be suitable for the project to this point. These sketches are presented in Appendix G.

Two additional papers have been identified - one presented at the Tenth Annual Fluidized-Bed Conference of the Council of Industrial Boiler Owners on EPC's CFBC and the other a section of a manual from the Portland Cement Association describing:

- cement hydration
- use of additives in solidification/stabilization (S/S) systems
- stabilization of metals
- role of calcium silicate hydrate in stabilization of metals
- individual metals in cement-based S/S systems
- wastes containing organic compounds
- waste components causing interference
- treatment characteristics

In addition, three transmissions, relating to the general topic of the project, have been pulled from the internet:

- the ADVACATE process developed with EPS funding as an alternate to wet lime scrubbing. The process uses a silicon-based material to achieve high levels of $SO_2$ removal at much lower costs. This process may have very interesting chemistry.
- the CO-7 PROCESS, a remediation process for the treatment and stabilization of metals and hydrocarbons in soil or water (see Appendix H).
- the relationship of the TCLP extract and the total metals in a solid. The notion needs to be instilled that "environmental compliance" and "good environmental science" may not be the same thing. For example, the TCLP test is a regulatory test only and not a procedure designed to model the behavior of the material in the real world. The relationship between metals associated with solids and those appearing in the TCLP leachate is not straightforward. The digestion procedure has been found not to solubilize all solids and thus to have a solid residue that may still retain some metals. In this case the TCLP leachate may show a higher level of metals than the digested solid analysis indicates should be present. This may be particularly the case for solids having a high lime content.

## Administrative Aspects

Public Relations. The draft of the project's portions of METC's Technology Status Report covering the status and accomplishments of major projects in the Fossil Energy Waste Management Program was reviewed and comments provided to METC on February 24, 1995. A copy of the report was received at Pitt on May 16, 1995.

At the request of Assistant Secretary for Fossil Energy Patricia Godley, a letter was provided on March 6, 1995 telling of the benefits of the public-private partnership carrying out this project. The letter was included by Assistant Secretary Godley in a compilation of nearly 300 letters provided to the House Appropriations Interior Subcommittee to illustrate the role of Federal investment in fossil energy research, development and demonstration.

During the quarter, the draft of a news release was reviewed. In addition, an article for the Pitt Engineering Monthly News Brief, similar to the news release, was developed and also reviewed. The article appeared in the April 1995 issue of the Pitt Engineering Monthly News Brief.

Contractual Arrangements. On March 9, 1995 a formal request was made through Pitt's Office of Research to METC for augmentation of the Phase One budget to reimburse DLC for the collection, bagging, storage and transportation of the Phase Two sample of PFBC by-product from the Tidd Station.

On April 21, 1995 notification was received by telephone that Jason Lewis has replaced Steven Bossart as the Contracting Officer's Representative for this project.

Shortly before the end of the quarter, the scope and format of the Continuation Application were determined. Preparation of the application to continue the project into its second phase has begun.

Personnel. An undergraduate summer student began full-time work on the project in mid-May and a second undergraduate researcher will begin a ten-week program of study in the first few days of June. The first student is being supported by the contract while the second will be assigned to the project by the Research Experience for Undergraduates (REU) Program, sponsored by the National Science Foundation (NSF). Pitt's Department of Chemical and Petroleum Engineering for the third year has been designated an REU site by NSF. The purpose of the REU Program is to expose undergraduates in science and engineering to academic science and engineering research at a number of sites around the country with the expectation that they will give serious consideration to enrolling in science and engineering graduate programs upon receipt of their bachelor degrees.

The student supported by the contract will provide general assistance to the project, although she will have the opportunity to focus a small portion of her time on one special aspect of the overall program. The REU student will be free to select any topic of interest related to the program. The Pitt research team has identified several research ideas that will be suggested to the undergraduate students:

- the rate of stabilization to distinguish between the rapid stabilization of the CONSOL by-product and the slow stabilization of the other by-products

- the enhancement of stabilizations by additives, including predictions from computerized thermodynamic programs

- the rate of solidification, including studies of the growth of crystals using the scanning electron microscope

- the anomaly that antimony is not present in the digestate but does appear in the TCLP extract for the EPC and Tidd by-products

- the effect of including sewage sludge incinerator ash or blends of wood and coal ash on stabilization and solidification
- stabilization and solidification of sewage sludge incinerator ash using the CCT by-products.

Monthly Highlights

Here are the highlights of the third three months of the first phase of the project.

February 18 - March 18, 1995

- Six by-product samples are collected.
- Phase Two sample of the PFBC by-product is collected from the Tidd Station.
- Testing plan for TCLP metals from treated residues is developed by MSI.
- Laboratory treatment of hazardous wastes with CCT by-products begins at MSI.
- Letter describing the project's benefits is provided to Assistant Secretary for Fossil Energy Patricia Godley.

March 18 - April 18, 1995

- First digestions are carried out at Pitt of by-products for total metals analysis.
- First analyses are conducted at Pitt for the four metals - antimony, beryllium, thallium and vanadium.
- Report of the initiation of the project is published in the April 1995 issue of the Pitt Engineering News Brief.

April 18 - May 18, 1995

- Decision is made not to conduct laboratory treatments of hazardous wastes with the AES Thames by-product.
- Discussions commence with the midwestern office of JTM toward identifying a fourth by-product.
- Project team meets at MSI to review the results of laboratory treatment of five wastes with three by-products.
- First of two undergraduate summer students join the Pitt project team.

Comparison of Progress with Milestone Chart

No tasks were scheduled for completion during the third quarter of Phase One and none were finished during this period. By submitting the second quarterly report on March 20, 1995, the project team met its only requirement for this reporting period.

The collection of the by-product samples by DLC has been completed but for two CONSOL samples. These last two samples will be drawn early in the fourth quarter of Phase One. The project is ahead of schedule in its collection of by-product for Phase Two, having collected the PFBC sample on February 21, 1995. Analysis of all Phase One by-product samples is nearing completion. More work is required to obtain approval for a fourth by-product to use in laboratory and commercial hazardous waste treatment in this project.

The identification of wastes has stalled. A sixth material has been determined to be satisfactory for use in Phase One of the project, but additional wastes have not appeared at MSI - in particular, wastes from sandblasting of paint from structures. Laboratory treatments using the wastes and by-products in hand are progressing well and initiation of solidification studies based upon all eighteen possible waste/by-product combinations currently available should be easily accomplished. The solidification studies will include both concrete and compressed soil-like accumulation, if the modification to the Test Plan that will be proposed early in the fourth quarter is accepted.

The Continuation Application should be completed within a few weeks of the beginning of the fourth quarter and the NEPA evaluations should begin shortly thereafter. Final work on the literature survey, further development of background and initiation and completion of the economic and commercial evaluation should all flow well during the coming three months.

Meetings, Telephone Conversations and Visits

Reports of meetings, telephone conversations and visits during the third quarter are given in Appendix I.

## PLAN FOR THE FOURTH QUARTER

During the fourth quarter of Phase One a number of activities will be undertaken. Many of them are continuations of work called for in the Test Plan dated October 17, 1994, but several are expected to be proposed in a modification to the Test Plan in early June.

Identification of the fourth by-product will continue to be pursued. Discussions are being held with both the midwestern and eastern regional offices of JTM in this quest. Three separate by-products are being considered, including still the AES Thames by-product.

MSI continues to seek the final four wastes for treatment. As they are identified, they will be treated with the three by-products already determined and with the fourth one when it is identified. The six wastes already determined will also be treated with the fourth by-product when it is identified.

The slow stabilization of those wastes with by-products which do not provide immediate stabilization will be examined by conducting a TCLP extraction on the treated waste cured for the usual period of time before placement in a structural fill.

Solidification tests will be conducted for successful by-product/waste combinations. For those combinations immediately successful, a water-containing blend having a 1 ½" to 2" slump will be placed in 3" by 6" cylinders and tested for compressive strength. For those combinations with successful slow stabilization, a moist blend having a maximum density as a compacted soil by the Proctor Test will be examined for both compressive strength and stress behavior, if the changes to the Test Plan are approved.

For by-products that are immediately successful in stabilizing one or more hazardous wastes, an economic evaluation will be developed. The approach described in the Test Plan will be used to carry out this task.

An assessment of environmental impacts of Phase Two will be conducted by CHMR. The method to be used for this assessment is also described in the Test Plan.

Finally, the literature survey, collection of background information, and the economic and commercial evaluation will be concluded and work will begin on the Topical Report due on October 17, 1995.

## APPENDIX A

# InterOffice Memo

**Date:** April 3, 1995
**To:** J. Beeghly
**From:** S. Tutokey
**Subject:** Samples Retrieved for Treatment of Metal-Laden Hazardous Waste with Clean Coal Technology By-Products

## LISTING OF BY-PRODUCTS COLLECTED DURING THE SECOND AND THIRD QUARTERS

cc: E. Goetz
~~Dr.~~ James T. Cobb

***REVISED 4/3/95***

| By-Product I.D. No. | Sample Date | Location | Rail Car Number | Ship Date | Sample Quantity | Samples Sent to Pitt | Samples Sent to Mill Ser. |
|---|---|---|---|---|---|---|---|
| AES Thames River #1 (Lab #94-3863) | 10/17/94 | Albright Mine | NAHX 97209 | 9/21/91 | 1 - 5 Gal | ----- | ----- |
| #2 (Lab #94-4209) | 11/10/94 | Albright Mine | CSXT 804949 | 10/14/94 | 6 - 5 Gal | Yes | ----- |
| #3 (Lab #94-4210) | 11/10/94 | Albright Mine | CSXT 813614 | 9/15/94 | 2 - 5 Gal | ----- | ----- |
| #4 (Lab #94-4773) | 12/1/94 | Albright Mine | CSXT 805753 | 11/18/94 | 5 - 5 Gal | Yes | Yes |
| #5 (Lab #94-4774) | 11/17/94 | Albright Mine | CSXT 351214 | 11/05/94 | 1 - 5 Gal | ----- | ----- |
| #6 (Lab #94-4775) | 11/17/94 | Albright Mine | CSXT 831431 | 11/05/94 | 1 - 5 Gal | ----- | ----- |
| #7 (Lab #94-4819) | 12/19/94 | Albright Mine | CSXT 829386 | 11/27/94 | 4 - 5 Gal | Yes | ----- |
| #8 (Lab #95-309) | Jan 95 | Albright Mine | CSXT 348914 | 12/27/94 | 1 - 5 Gal | ----- | ----- |
| #9 (Lab #95-310) | Jan 95 | Albright Mine | CSXT 803535 | 12/28/94 | 1 - 5 Gal | ----- | ----- |
| #10 (Lab #95-311) | Jan 95 | Albright Mine | CSXT 806643 | 12/28/94 | 1 - 5 Gal | ----- | ----- |

| By-Product I.D. No. | Sample Date | Location | Rail Car Number | Ship Date | Sample Quantity | Samples Sent to Pitt | Samples Sent to Mill Ser. |
|---|---|---|---|---|---|---|---|
| Ebensburg Power Co. #1 (Lab #94-3982) | 10/25/94 | Ebensburg PA | ----- | ----- | 1 - 5 Gal | ----- | ----- |
| (Bed Ash) #1a (Lab #94-3984) | 10/25/94 | Ebensburg PA | ----- | ----- | 1 - 5 Gal | ----- | ----- |
| (Bag House Dust) #1b (Lab #94-3983) | 10/25/94 | Ebensburg PA | ----- | ----- | 1 - 5 Gal | ----- | ----- |
| #2 (Lab #94-3981) | 10/28/94 | Ebensburg PA | ----- | ----- | 2 - 5 Gal | Yes | Yes |
| #3 (Lab #94-4419) | 11/18/94 | Ebensburg PA | ----- | ----- | 6 - 5 Gal | Yes | Yes |
| #4 (Lab #94-4778) | 11/25/94 | Ebensburg PA | ----- | ----- | 6 - 5 Gal | Yes | Yes |
| #5 (Lab #95-009) | 12/27/94 | Ebensburg PA | ----- | ----- | 6 - 5 Gal | Yes | ----- |
| #6 (Lab #95-354) | 2/9/95 | Ebensburg PA | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #7 (Lab #95-466) | 2/14/95 | Ebensburg PA | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #8 (Lab #95-467) | 2/15/95 | Ebensburg PA | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #9 (Lab #95-468) | 2/16/95 | Ebensburg PA | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #10 (Lab #95-469) | 2/23/95 | Ebensburg PA | ----- | ----- | 2 - 5 Gal | ----- | ----- |

| By-Product I.D. No. | Sample Date | Location | Rail Car Number | Ship Date | Sample Quantity | Samples Sent to Pitt | Samples Sent to Mill Ser. |
|---|---|---|---|---|---|---|---|
| Tidd Station #1 (Lab #94-4777) | 9/21/94 | Brilliant Ohio | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #2 (Lab #94-4776) | 12/12/94 | Brilliant Ohio | ----- | ----- | 6 - 5 Gal | Yes | Yes |
| #3 (Lab #94-4817) | 12/15/94 | Brilliant Ohio | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #4 (Lab #94-4818) | 12/20/94 | Brilliant Ohio | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| 5 (Lab #95-007) | 12/22/94 | Brilliant Ohio | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #6 (Lab #95-008) | 12/28/94 | Brilliant Ohio | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #7 (Lab #95-404) | 2/1/95 | Brilliant Ohio | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| * #8 (Lab #95-433) | 2/21/95 | Brilliant Ohio | ----- | ----- | 6 - 5 Gal | Yes | Yes |
| #9 (Lab #95-722) | 2/27/95 | Brilliant Ohio | ----- | ----- | 2 - 5 Gal | ----- | ----- |
| #10 (Lab #95-885) | 3/8/95 | Brilliant Ohio | ----- | ----- | 6 - 5 Gal | Yes | ----- |

* Note: This cyclone ash sampled during loading of super sacks.

| By-Product I.D. No. | Sample Date | Location | Rail Car Number | Ship Date | Sample Quantity | Samples Sent to Pitt | Samples Sent to Mill Ser. |
|---|---|---|---|---|---|---|---|
| CONSOL #1 (Lab #94-4769) | 11/23/94 | Waynesburg Terminal | ACCX 1015 | ----- | 5 - 5 Gal | Yes | Yes |
| #2 (Lab #94-4770) | 11/21/94 | Waynesburg Terminal | ACCX 1039 | ----- | 2 - 5 Gal | ----- | ----- |
| #3 (Lab #94-4771) | 11/22/94 | Waynesburg Terminal | ACCX 1053 | ----- | 2 - 5 Gal | ----- | ----- |
| #4 (Lab #94-4772) | 11/22/94 | Waynesburg Terminal | ACCX 1012 | ----- | 2 - 5 Gal | ----- | ----- |
| #5 (Lab #95-106) | 12/14/95 | Waynesburg Terminal | ACCX 1021 | ----- | 2 - 5 Gal | ----- | ----- |
| #6 (Lab #95-107) | 12/16/94 | Waynesburg Terminal | ACCX 1051 | ----- | 2 - 5 Gal | ----- | ----- |
| #7 (Lab #95-720) | 3/8/95 | Waynesburg Terminal | ACCX 1012 | ----- | 4 - 5 Gal | Yes | ----- |
| #8 (Lab #95-0721) | 3/8/95 | Waynesburg Terminal | ACCX 1049 | ----- | 2 - 5 Gal | ----- | ----- |

# APPENDIX B

# BY-PRODUCT ANALYSES BY DLC

*Dravo Lime Co. Research Center*
*Project # 5256 University of Pittsburgh*
*2nd Qtr. Report*
*February, 1995*

***Sample Analysis Report:***
***Ebensburg Power Co.***
***CFBC Ash***

| Sample ID | #1 Ash Silo | #1A Bed Ash | #1B Fly Ash | #2 Ash Silo | #4 Ash Silo |
|---|---|---|---|---|---|
| Sampling Date | 10/25/94 | 10/25/94 | 10/25/94 | 10/28/94 | 11/25/94 |
| Lab# | 94-3982 | 94-3984 | 94-3983 | 94-3981 | 94-4778 |
| **Geo Chemical, %:** | | | | | |
| CaO | | | | 10.15 | |
| MgO | | | | 1.15 | |
| $SiO_2$ | | | | 48.47 | |
| $Fe_2O_3$ | | | | 6.76 | |
| $Al_2O_3$ | | | | 18.94 | |
| $CO_2$ | | | | 0.68 | |
| Total Sulfur as S | | | | 2.22 | |
| $SO_3$ | | | | 4.99 | |
| $SO_2$ | | | | 0.44 | |
| LOI @ 600 °C | | | | | |
| LOI @ 1100 °C | | | | 6.40 | |
| Total of Elements Determined (calculated to oxide basis) | | | | 97.30 | |
| **Reactivity:** | | | | | |
| Temperature Rise F° | 17 | | | 17 | 6 |
| Calc. Carb. Equiv., %$CaCO_3$ | 13.0 | | | 11.3 | 11.4 |
| Available Lime Index, % CaO | 3.4 | 2.1 | 2.1 | 3.4 | 3.7 |
| pH (Soil) | 12.42 @ 25 °C | | | 12.42 @ 25 C | 12.59 @ 24 C |
| Mixed Ratio(lbs/gal) | 18 | | | 17 | 18 |
| **Physical Properties:** | | | | | |
| Specific Gravity, g/cc | 2.68 | | | 2.68 | 2.74 |
| Bulk Density(Loose), $lb/ft^3$ | 63 | | | 56 | 49 |
| Bulk Density(Tamped), $lb/ft^3$ | 70 | | | 63 | 57 |
| Blaine Fineness, $cm^2/g$ | 7860 | | | 7270 | 9080 |
| Passing 200 Mesh, % | 42 | | | 49 | 61 |
| Passing 325 Mesh, % | 36 | | | 39 | 55 |

*Dravo Lime Co. Research Center*
*Project # 5256 University of Pittsburgh*
*2nd Qtr. Report*
*February, 1995*

***Sample Analysis Report:***

## *CONSOL - Carney's Point*
## *Spray Dryer Fly Ash*

| **Sample ID** | #1 Fly Ash | #2 Fly Ash | #3 Fly Ash | #4 Fly Ash |
|---|---|---|---|---|
| Sampling Date | 11/23/94 | 11/21/94 | 11/22/94 | 11/22/94 |
| Lab# | 94-4769 | 94-4770 | 94-4771 | 94-4772 |
| **Geo Chemical, %:** | | | | |
| CaO | 25.41 | | | |
| MgO | 0.70 | | | |
| $SiO_2$ | 22.33 | | | |
| $Fe_2O_3$ | 6.23 | | | |
| $Al_2O_3$ | 11.40 | | | |
| $CO_2$ | 3.58 | | | |
| Total Sulfur as S | 9.62 | | | |
| $SO_3$ | 1.79 | | | |
| $SO_2$ | 17.79 | | | |
| LOI @ 600 °C | 3.17 | | | |
| LOI @ 1100 °C | 14.68 | | | |
| Total of Elements Determined (calculated to oxide basis) | 100.33 | | | |
| **Reactivity:** | | | | |
| Temperature Rise F° | 1 | 2 | 2 | 1 |
| Calc. Carb. Equiv., %$CaCO_3$ | 42.5 | 42.1 | 42.2 | 42.8 |
| Available Lime Index, % CaO | 3.2 | 2.3 | 3.0 | 2.2 |
| pH (Soil) | 12.36 @ 26 °C | 12.30 @ 23 °C | 12.25 @ 23 °C | 12.29 @ 24 °C |
| Mixed Ratio(lbs/gal) | 13 | 13 | 13 | 13 |
| **Physical Properties:** | | | | |
| Specific Gravity, g/cc | 2.40 | 2.40 | 2.42 | 2.42 |
| Bulk Density(Loose), $lb/ft^3$ | 35 | 36 | 37 | 35 |
| Bulk Density(Tamped), $lb/ft^3$ | 42 | 42 | 42 | 43 |
| Blaine Fineness, $cm^2/g$ | 13190 | 12680 | 11510 | 11120 |
| Passing 200 Mesh, % | 96 | 99 | 98 | 92 |
| Passing 325 Mesh, % | 83 | 90 | 81 | 76 |

Dravo Lime Co. *Research Center*
*Project # 5256* *University of Pittsburgh*
*2nd Qtr. Report*
*February, 1995*

*Sample Analysis Report:*

## *AES Thames River*
## *CFBC Ash*

| Sample ID | #1 Fly Ash | #2 Fly Ash | #3 Fly Ash | #4 Fly Ash | #5 Fly Ash | #6 Fly Ash | #7 Fly Ash |
|---|---|---|---|---|---|---|---|
| Sampling Date | 10/17/94 | 11/10/94 | 11/10/94 | 12/01/94 | 11/17/94 | 11/17/94 | 12/19/94 |
| Lab# | 94-3863 | 94-4209 | 94-4210 | 94-4773 | 94-4774 | 94-4775 | 94-4819 |
| **Geo Chemical, %:** | | | | | | | |
| CaO | | 18.41 | | 15.11 | | | |
| MgO | | 0.60 | | 0.62 | | | |
| $SiO_2$ | | 25.28 | | 30.60 | | | |
| $Fe_2O_3$ | | 6.41 | | 5.11 | | | |
| $Al_2O_3$ | | 14.41 | | 17.43 | | | |
| $CO_2$ | | 1.64 | | 1.32 | | | |
| Total Sulfur as S | | 3.85 | | 3.03 | | | |
| $SO_3$ | | 8.61 | | 6.87 | | | |
| $SO_2$ | | 0.80 | | 0.56 | | | |
| LOI @ 600 °C | | | | | | | |
| LOI @ 1100 °C | | 21.61 | | 20.06 | | | |
| Total of Elements Determined (calculated to oxide basis) | | 96.13 | | 96.36 | | | |
| **Reactivity:** | | | | | | | |
| Temperature Rise F° | 13 | 13 | 13 | 4 | 4 | 6 | 7 |
| Calc. Carb. Equiv., %$CaCO_3$ | 17.2 | 20.3 | 20.4 | 15.4 | 24.6 | 18.3 | 25.1 |
| Available Lime Index, % CaO | 6.1 | 6.9 | 7.0 | 5.8 | 10.5 | 9.5 | 9.0 |
| pH (Soil) | 12.34 @ 25 °C | 12.10 @ 26 °C | 12.06 @ 26 °C | 12.60 @ 24 °C | 12.59 @ 24°C | 12.57 @ 25 °C | 12.55 @ 25 °C |
| Mixed Ratio(lbs/gal) | 12 | 12 | 12 | 12 | 12 | 12 | 18 |
| **Physical Properties:** | | | | | | | |
| Specific Gravity, g/cc | 2.52 | 2.52 | 2.52 | 2.50 | 2.66 | 2.60 | 2.72 |
| Bulk Density(Loose), $lb/ft^3$ | 37 | 35 | 41 | 38 | 38 | 38 | 38 |
| Bulk Density(Tamped), $lb/ft^3$ | 44 | 40 | 46 | 46 | 47 | 46 | 45 |
| Blaine Fineness, $cm^2/g$ | 5920 | 6390 | 6240 | 6620 | 6520 | 6390 | 7450 |
| Passing 200 Mesh, % | 85 | 92 | 94 | 94 | 97 | 90 | 96 |
| Passing 325 Mesh, % | 75 | 78 | 82 | 88 | 82 | 75 | 83 |

*Dravo Lime Co.* *Research Center*
*Project # 5256* *University of Pittsburgh*
*2nd Qtr. Report*
*February, 1995*

*Sample Analysis Report:*

## Tidd-AEP

## *PFBC Cyclone Ash*

| Sample ID | # 1 Cyclone Ash | # 2 Cyclone Ash | # 3 Cyclone Ash | # 4 Cyclone Ash |
|---|---|---|---|---|
| Sampling Date | 09/21/94 | 12/12/94 | 12/15/94 | 12/20/94 |
| Lab# | 94-4777 | 94-4776 | 94-4817 | 94-4818 |
| **Geo Chemical, %:** | | | | |
| CaO | | 22.13 | | |
| MgO | | 14.38 | | |
| $SiO_2$ | | 19.93 | | |
| $Fe_2O_3$ | | 9.02 | | |
| $Al_2O_3$ | | 7.75 | | |
| $CO_2$ | | 12.57 | | |
| Total Sulfur as S | | 4.59 | | |
| $SO_3$ | | 10.60 | | |
| $SO_2$ | | 0.69 | | |
| LOI @ 600 °C | | | | |
| LOI @ 1100 °C | | 13.54 | | |
| Total of Elements Determined (calculated to oxide basis) | | 98.04 | | |
| **Reactivity:** | | | | |
| Temperature Rise F° | 2 | 2 | 11 | 5 |
| Calc. Carb. Equiv., %$CaCO_3$ | 53.8 | 53.4 | 45.9 | 52.0 |
| Available Lime Index, % CaO | 0.5 | 1.0 | 1.1 | 1.0 |
| pH (Soil) | 10.02 @ 23 C | 11.92 @ 25 C | 11.03 @ 22 C | 11.91 @ 22 C |
| Mixed Ratio(lbs/gal) | 25 | 25 | 20 | 20 |
| **Physical Properties:** | | | | |
| Specific Gravity, g/cc | 2.85 | 2.88 | 2.87 | 2.88 |
| Bulk Density(Loose), $lb/ft^3$ | 58 | 64 | 60 | 60 |
| Bulk Density(Tamped), $lb/ft^3$ | 67 | 70 | 72 | 70 |
| Blaine Fineness, $cm^2/g$ | 6150 | 5610 | 5580 | 5480 |
| Passing 200 Mesh, % | 91 | 92 | 81 | 89 |
| Passing 325 Mesh, % | 85 | 85 | 73 | 83 |

# APPENDIX C

## BY-PRODUCT ANALYSES BY MSI AND PITT

| | Property | Units | Consol #1 | Tidd #2 | EPC #2 | EPC #3 | EPC #4 | EPC #5 |
|---|---|---|---|---|---|---|---|---|
| Total Metals | Antimony (Sb) | mg/kg | <4 | <4 | | <4 | | |
| | Arsenic (As) | mg/kg | 41 | 140 | | 95 | | |
| | Barium (Ba) | mg/kg | 97 | 150 | | 160 | | |
| | Beryllium (Be) | mg/kg | 2.22 | 2.60 | | 2.00 | | |
| | Cadmium (Cd) | mg/kg | 6.6 | 4.8 | | 10 | | |
| | Chromium (Cr) | mg/kg | 29 | 15 | | 50 | | |
| | Copper (Cu) | mg/kg | 20 | 17 | | 35 | | |
| | Lead (Pb) | mg/kg | 3 | 4.6 | | 3.6 | | |
| | Mercury (Hg) | mg/kg | 0.55 | <0.10 | | 1.1 | | |
| | Nickel (Ni) | mg/kg | 23 | 12 | | 21 | | |
| | Selenium (Se) | mg/kg | <0.2 | <0.2 | | <0.2 | | |
| | Silver (Ag) | mg/kg | <2.0 | <2.0 | | <2.0 | | |
| | Thallium (Th) | mg/kg | <0.5 | <4 | | <4 | | |
| | Vanadium (V) | mg/kg | 54.15 | 26.10 | | 55.25 | | |
| | Zinc (Zn) | mg/kg | 34 | 78 | | 52 | | |
| | | | | | | | | |
| TCLP Metals | Antimony (Sb) | ug/L | <20 | 21.9 | | 23.7 | | |
| | Arsenic (As) | mg/L | <0.1 | <0.1 | | 0.89 | | |
| | Barium (Ba) | mg/L | <5.0 | <5.0 | | <5.0 | | |
| | Beryllium (Be) | ug/L | <1 | <1 | | <1 | | |
| | Cadmium (Cd) | mg/L | <0.1 | <0.1 | <0.05 | <0.1 | <0.05 | <0.05 |
| | Chromium (Cr) | mg/L | <0.1 | <0.1 | <0.50 | <0.1 | <0.50 | <0.50 |
| | Copper (Cu) | mg/L | <1.0 | <1.0 | <0.20 | <1.0 | <0.20 | <0.20 |
| | Lead (Pb) | mg/L | <0.1 | <0.1 | <1.00 | <0.1 | <1.00 | <1.00 |
| | Mercury (Hg) | mg/L | <0.01 | <0.01 | | <0.01 | | |
| | Nickel (Ni) | mg/L | <0.1 | <0.1 | <0.30 | <0.1 | <0.30 | <0.30 |
| | Selenium (Se) | mg/L | <0.1 | <0.1 | | <0.1 | | |
| | Silver (Ag) | mg/L | <0.1 | <0.1 | | <0.1 | | |
| | Thallium (Th) | ug/L | <5 | <5 | | <5 | | |
| | Vanadium (V) | ug/L | 74.2 | 12.8 | | 316 | | |
| | Zinc (Zn) | mg/L | <1.0 | <1.0 | <0.05 | <1.0 | 0.127 | 0.099 |
| | | | | | | | | |
| ASTM Metals | Antimony (Sb) | mg/L | | | | | | |
| | Arsenic (As) | mg/L | | | | | | |
| | Barium (Ba) | mg/L | | | | | | |
| | Beryllium (Be) | mg/L | | | | | | |
| | Cadmium (Cd) | mg/L | <0.05 | <0.05 | <0.05 | <0.05 | | |
| | Chromium (Cr) | mg/L | <0.50 | <0.50 | <0.50 | <0.50 | | |
| | Copper (Cu) | mg/L | <0.20 | <0.20 | <0.20 | <0.20 | | |
| | Lead (Pb) | mg/L | <1.00 | <1.00 | <1.00 | <1.00 | | |
| | Mercury (Hg) | mg/L | | | | | | |
| | Nickel (Ni) | mg/L | <0.30 | <0.30 | <0.30 | <0.30 | | |
| | Selenium (Se) | mg/L | | | | | | |
| | Silver (Ag) | mg/L | | | | | | |
| | Thallium (Th) | mg/L | | | | | | |
| | Vanadium (V) | mg/L | | | | | | |
| | Zinc (Zn) | mg/L | <0.05 | <0.05 | <0.05 | <0.05 | | |

| | Property | Units | AES Thames River #2 | AES Thames River #4 | AES Thames River #7 |
|---|---|---|---|---|---|
| Total Metals | Antimony (Sb) | mg/kg | | <4 | |
| | Arsenic (As) | mg/kg | | 21 | |
| | Barium (Ba) | mg/kg | | 170 | |
| | Beryllium (Be) | mg/kg | | 8.84 | |
| | Cadmium (Cd) | mg/kg | | 2.2 | |
| | Chromium (Cr | mg/kg | | 52 | |
| | Copper (Cu) | mg/kg | | 30 | |
| | Lead (Pb) | mg/kg | | 4.9 | |
| | Mercury (Hg) | mg/kg | | 0.66 | |
| | Nickel (Ni) | mg/kg | | 280 | |
| | Selenium (Se) | mg/kg | | 1.4 | |
| | Silver (Ag) | mg/kg | | <2.0 | |
| | Thallium (Th) | mg/kg | | <4 | |
| | Vanadium (V) | mg/kg | | 97.60 | |
| | Zinc (Zn) | mg/kg | | 37 | |
| | | | | | |
| TCLP Metals | Antimony (Sb) | ug/L | | <20 | |
| | Arsenic (As) | mg/L | | <0.1 | |
| | Barium (Ba) | mg/L | | <5.0 | |
| | Beryllium (Be) | ug/L | | <1 | |
| | Cadmium (Cd) | mg/L | <0.05 | <0.1 | <0.05 |
| | Chromium (Cr | mg/L | <0.50 | <0.1 | <0.50 |
| | Copper (Cu) | mg/L | <0.20 | <1.0 | <0.20 |
| | Lead (Pb) | mg/L | <1.00 | <0.1 | <1.00 |
| | Mercury (Hg) | mg/L | | <0.01 | |
| | Nickel (Ni) | mg/L | <0.30 | <0.1 | <0.30 |
| | Selenium (Se) | mg/L | | <0.1 | |
| | Silver (Ag) | mg/L | | <0.1 | |
| | Thallium (Th) | ug/L | | <5 | |
| | Vanadium (V) | ug/L | | 412 | |
| | Zinc (Zn) | mg/L | <0.05 | <1.0 | <0.05 |
| | | | | | |
| ASTM Metals | Antimony (Sb) | mg/L | | | |
| | Arsenic (As) | mg/L | | | |
| | Barium (Ba) | mg/L | | | |
| | Beryllium (Be) | mg/L | | | |
| | Cadmium (Cd) | mg/L | <0.05 | <0.05 | |
| | Chromium (Cr | mg/L | <0.50 | <0.50 | |
| | Copper (Cu) | mg/L | <0.20 | <0.20 | |
| | Lead (Pb) | mg/L | <1.00 | <1.00 | |
| | Mercury (Hg) | mg/L | | | |
| | Nickel (Ni) | mg/L | <0.30 | <0.30 | |
| | Selenium (Se) | mg/L | | | |
| | Silver (Ag) | mg/L | | | |
| | Thallium (Th) | mg/L | | | |
| | Vanadium (V) | mg/L | | | |
| | Zinc (Zn) | mg/L | <0.05 | <0.05 | |

# APPENDIX D

## ANALYSIS OF SUITABLE HAZARDOUS WASTES

| | Property | Units | Battery Sludge | Munitions Soil | Industrial Soil | Sewage Pl Soil | Furnace Dust | Mun. Waste Dust |
|---|---|---|---|---|---|---|---|---|
| Total Metals | Antimony (Sb) | mg/kg | 35.3 | 18.6 | >60 | | <4 | 54.1 |
| | Arsenic (As) | mg/kg | <20 | <20 | <20 | 4.4 | <20 | 84 |
| | Barium (Ba) | mg/kg | 13 | 130 | 130 | 84 | 34 | 550 |
| | Beryllium (Be) | mg/kg | <0.2 | 0.3 | 0.46 | | <0.2 | 0.78 |
| | Cadmium (Cd) | mg/kg | 3.0 | 4.8 | 5.4 | <2.0 | 55 | 630 |
| | Chromium (Cr) | mg/kg | 12 | 59 | 22 | 8.7 | 260 | 130 |
| | Copper (Cu) | mg/kg | 30 | 210 | 260 | 64 | 57 | 1300 |
| | Lead (Pb) | mg/kg | 3000 | 1200 | 5000 | 750 | 1400 | 5700 |
| | Mercury (Hg) | mg/kg | 0.14 | 0.20 | 3.2 | 0.36 | 0.30 | 4.7 |
| | Nickel (Ni) | mg/kg | 15 | 19 | 26 | <10 | 130 | 96 |
| | Selenium (Se) | mg/kg | <0.2 | <0.2 | <0.2 | 0.36 | <0.2 | 85 |
| | Silver (Ag) - | mg/kg | <2.0 | 3.6 | <2.0 | <2.0 | <2.0 | 6.9 |
| | Thallium (Th) | mg/kg | <0.5 | <0.5 | <0.5 | | <0.5 | <0.5 |
| | Vanadium (V) | mg/kg | 1.8 | 26.28 | 18.76 | | 75.74 | 39.4 |
| | Zinc (Zn) | mg/kg | 30 | 580 | 660 | 150 | 41000 | 23000 |
| | | | | | | | | |
| TCLP Metals | Antimony (Sb) | mg/L | 328.2 | 120.8 | 201.1 | | 34.5 | 404.4 |
| | Arsenic (As) | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.2 |
| | Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 |
| | Beryllium (Be) | mg/L | <1 | <1 | <1 | | <1 | <1 |
| | Cadmium (Cd) | mg/L | 0.19 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | Chromium (Cr) | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | Copper (Cu) | mg/L | 1.3 | 1.6 | <1 | <1 | <1 | <1 |
| | Lead (Pb) | mg/L | 20 | 26 | 80 | 7.8 | 14 | 20 |
| | Mercury (Hg) | mg/L | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| | Nickel (Ni) | mg/L | 0.78 | 0.041 | 0.23 | <0.01 | <0.01 | <0.1 |
| | Selenium (Se) | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | Silver (Ag) | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | Thallium (Th) | mg/L | <5 | <5 | <5 | | <5 | 26.6 |
| | Vanadium (V) | mg/L | <10 | <10 | <10 | | 12.2 | <10 |
| | Zinc (Zn) | mg/L | 2.9 | 8.2 | 17 | 3.9 | 4.4 | 2.1 |

# APPENDIX E

## PARAMETERS TO DETERMINE ACHIEVEMENT OF LDR TREATMENT STANDARDS

| | WASTE | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | Battery Sludge | Furnace Dust | Industrial Soil | Munitions Soil | Mun. Waste Dust | Sewage Plant Soil |
| Antimony | X (2) | | | | X (2) | Pending |
| Arsenic | X (1) | X (1) | X (1) | X (1) | X (1,2) | X (1) |
| Barium | X (1) | X (1) | X (1,2) | X (1,2) | X (1,2) | X (1) |
| Beryllium | X (1) | X (1) | X (1,2) | X (1,2) | X (1,2) | Pending |
| Cadmium | X (1,2) | X (1,2) | X (1,2) | X (1,2) | X (1,2) | X (1) |
| Chromium | X (1) | X (1,2) | X (1,2) | X (1,2) | X (1,2) | X (1) |
| Copper | | | | | | |
| Lead | X (2) | X (2) | X (2) | X (2) | X (2) | X (2) |
| Mercury | X (1) | X (1) | X (1,2) | X (1) | X (1,2) | X (1) |
| Nickel | X (1) | X (1,2) | X (1) | X (1) | X (1,2) | X (1) |
| Selenium | | | | | X (2) | |
| Silver | | | | | X (2) | |
| Thallium | | | | | | Pending |
| Vanadium | X (1) | X (1,2) | X (1,2) | X (1,2) | X (1,2) | Pending |
| Zinc | | X (2) | X (2) | X (2) | X (2) | X (2) |

Notes: (1) Based on concentration in one or more byproduct samples.
(2) Based on concentration in waste sample.

# APPENDIX F - ANALYSIS OF THE TREATED WASTES

TIDD

IMMEDIATE

| | | Battery Sludge | | | Munitions Soil | | | Industrial Soil | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | 0.2310 | 0.1798 | 0.1148 | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | 0.0028 | 0.0012 | <.001 | 0.0010 | 0.0011 | <0.001 | 0.0023 | <.001 | <.001 |
| Cadmium (Cd) | mg/L | 0.19 | 0.15 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Chromium (Cr) | mg/L | 0.31 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead (Pb) | mg/L | 6.5 | 10 | 4.1 | 10 | 13 | 1.2 | 13 | 7 | 1.7 |
| Mercury (Hg) | mg/L | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nickel (Ni) | mg/L | 0.92 | 0.63 | 0.44 | <0.10 | 0.32 | <0.10 | 0.25 | 0.12 | 1.8 |
| Selenium (Se) | mg/L | N/A | N/A | N\A | N/A | N/A | N\A | N/A | N/A | N/A |
| Silver (Ag) | mg/L | N/A | N/A | N/A | N/A | N/A | N\A | N/A | N/A | N/A |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N\A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Zinc (Zn) | mg/L | N/A | N/A | N/A | 7.1 | 5.2 | 1 | 15 | 7 | 2.9 |

TIDD

24HOURS

| | | Battery Sludge | | | Munitions Soil | | | Industrial Soil | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | 0.3304 | 0.1324 | 0.1356 | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | 0.0016 | <0.001 | <0.001 | 0.0020 | 0.0011 | <0.001 | 0.002 | <0.001 | <0.001 |
| Cadmium (Cd) | mg/L | 0.18 | 0.14 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Chromium (Cr) | mg/L | 0.27 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead (Pb) | mg/L | 6.8 | 6.6 | 5.1 | 16 | 23 | 0.34 | 17 | 22 | 1.6 |
| Mercury (Hg) | mg/L | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nickel (Ni) | mg/L | 0.78 | 0.6 | 0.44 | <0.10 | <0.10 | <0.10 | 0.29 | 0.15 | <0.10 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Silver (Ag) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Zinc (Zn) | mg/L | N/A | N/A | N/A | 7.7 | 5 | <1.0 | 14 | 7.6 | 2.4 |

## TIDD

IMMEDIATE

| Property | Units | BOF Dust 10% | BOF Dust 30% | BOF Dust 50% | Municipal Waste Dust 10% | Municipal Waste Dust 30% | Municipal Waste Dust 50% |
|---|---|---|---|---|---|---|---|
| Antimony (Sb) | mg/L | N/A | N/A | N/A | 0.5460 | 0.5420 | 0.3982 |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium (Cd) | mg/L | <0.10 | <0.10 | <0.10 | 25 | 18 | 14 |
| Chromium (Cr) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | | | |
| Lead (Pb) | mg/L | 20 | 14 | 13 | 16 | 17 | 9.1 |
| Mercury (Hg) | mg/L | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nickel (Ni) | mg/L | <0.10 | <0.10 | <0.10 | 0.64 | 0.45 | 0.35 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Silver (Ag) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | 0.0112 | <0.010 | <0.010 | <0.010 | <0.010 |
| Zinc (Zn) | mg/L | 4.2 | 4.3 | 4.3 | 550 | 400 | 280 |

## TIDD

24 HOURS

| Property | Units | BOF Dust 10% | BOF Dust 30% | BOF Dust 50% | Municipal Waste Dust 10% | Municipal Waste Dust 30% | Municipal Waste Dust 50% |
|---|---|---|---|---|---|---|---|
| Antimony (Sb) | mg/L | N/A | N/A | N/A | 0.3362 | 0.3308 | 0.2576 |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium (Cd) | mg/L | <0.10 | <0.10 | <0.10 | 30 | 17 | 13 |
| Chromium (Cr) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | | | |
| Lead (Pb) | mg/L | 19 | 15 | 9.6 | 13 | 16 | 12 |
| Mercury (Hg) | mg/L | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nickel (Ni) | mg/L | <0.10 | <0.10 | <0.10 | 0.7 | 0.46 | 0.35 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Silver (Ag) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | <0.010 | <0.010 | N/A | N/A | N/A |
| Zinc (Zn) | mg/L | 3.9 | 3.7 | 3.3 | 700 | 370 | 270 |

## Consol

| IMMEDIATE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Battery Sludge | | | Munitions Soil | | | Industrial Soil | | |
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | 0.4070 | 0.3976 | 0.3032 | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic (As) | mg/L | <.10 | <.10 | <.10 | <.10 | 0.11 | <.10 | <.01 | 0.12 | <.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <.0010 | 0.0025 | 0.0027 | <.001 | 0.0023 | 0.0020 | <.001 | 0.0019 | 0.0023 |
| Cadmium (Cd) | mg/L | 0.11 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Chromium (Cr) | mg/L | <.10 | 0.23 | 0.15 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead (Pb) | mg/L | 0.14 | 0.28 | 0.19 | 0.37 | 0.41 | 0.28 | 0.54 | 0.54 | 0.37 |
| Mercury (Hg) | mg/L | <.01 | <.01 | <.01 | <.01 | <.01 | <01 | <.01 | <.01 | <.01 |
| Nickel (Ni) | mg/L | 0.71 | 0.69 | 0.58 | 0.1 | 0.15 | 0.15 | 0.18 | 0.28 | 0.25 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Silver (Ag) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <.0100 | 0.0603 | 0.0532 | <.010 | 0.0331 | 0.0393 | <.010 | 0.0163 | 0.0191 |
| Zinc (Zn) | mg/L | N/A | N/A | N/A | 4.3 | 8 | 5.3 | 5.2 | 8.3 | 8.4 |

## Consol

| 24HOURS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Battery Sludge | | | Munitions Soil | | | Industrial Soil | | |
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | 0.3808 | 0.3890 | 0.2342 | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic (As) | mg/L | <.10 | <.10 | <.10 | <.10 | 0.11 | <.10 | <.10 | <.10 | <.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <.001 | 0.0027 | 0.0029 | <.001 | 0.0021 | 0.0021 | <.001 | 0.0027 | 0.0024 |
| Cadmium (Cd) | mg/L | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Chromium (Cr) | mg/L | <.10 | 0.25 | 0.17 | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead (Pb) | mg/L | 0.15 | 0.21 | 0.21 | 0.41 | 0.35 | 0.28 | 0.15 | 0.26 | 0.21 |
| Mercury (Hg) | mg/L | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 |
| Nickel (Ni) | mg/L | 0.49 | 0.68 | 0.56 | <.10 | 0.11 | 0.12 | 0.14 | 0.27 | 0.22 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Silver (Ag) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <.010 | 0.034 | 0.0566 | <.010 | 0.0463 | 0.0270 | <.010 | 0.0201 | 0.0291 |
| Zinc (Zn) | mg/L | N/A | N/A | N/A | 9.9 | 6.7 | 5.1 | 8.2 | 9.4 | 13 |

**Consol**

| IMMEDIATE | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | BOF Dust | | | Municipal Waste Dust | | |
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | N/A | N/A | N/A | 0.8472 | 0.3982 | 0.4460 |
| Arsenic (As) | mg/L | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| Cadmium (Cd) | mg/L | <.10 | <.10 | <.10 | 22 | 13 | 8.0 |
| Chromium (Cr) | mg/L | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | | | |
| Lead (Pb) | mg/L | 1.5 | 5.1 | 6.9 | 1.3 | 0.46 | 0.26 |
| Mercury (Hg) | mg/L | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 |
| Nickel (Ni) | mg/L | <.10 | <.10 | <.10 | 0.63 | 0.46 | 0.4 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | <.10 | <.10 | <.10 |
| Silver (Ag) | mg/L | N/A | N/A | N/A | <.10 | <.10 | <.10 |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <.010 | <.010 | <.010 | 0.171 | 0.282 | 0.641 |
| Zinc (Zn) | mg/L | 4.1 | 3.9 | 3.1 | 740 | 410 | 310 |

**Consol**

| 24 HOURS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | BOF Dust | | | Municipal Waste Dust | | |
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | N/A | N/A | N/A | 0.3472 | 0.1410 | 0.2060 |
| Arsenic (As) | mg/L | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| Cadmium (Cd) | mg/L | <.10 | <.10 | <.10 | 24 | 14 | 9.0 |
| Chromium (Cr) | mg/L | <.10 | <.10 | <.10 | <.10 | <.10 | <.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | | | |
| Lead (Pb) | mg/L | 17 | 9.6 | 4.3 | 1.6 | 0.45 | 0.27 |
| Mercury (Hg) | mg/L | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 |
| Nickel (Ni) | mg/L | <.10 | <.10 | <.10 | 0.68 | 0.55 | 0.36 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | <.10 | <.10 | <.10 |
| Silver (Ag) | mg/L | N/A | N/A | N/A | <.10 | <.10 | <.10 |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <.010 | <.010 | <.010 | 0.0193 | 0.0169 | 0.0519 |
| Zinc (Zn) | mg/L | 3.9 | 3.3 | 2.6 | 650 | 330 | 280 |

## EPC

| IMMEDIATE | | Battery Sludge | | | Munitions Soil | | | Industrial Soil | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | 0.2016 | 0.1094 | 0.068 | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium (Cd) | mg/L | 0.2 | 0.13 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Chromium (Cr) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead (Pb) | mg/L | 7.8 | 46 | 13 | 34 | 17 | 5.6 | 17 | 17 | 0.85 |
| Mercury (Hg) | mg/L | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nickel (Ni) | mg/L | 0.58 | 0.46 | 0.31 | <0.10 | <0.10 | <0.10 | 0.18 | 0.13 | <0.10 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Silver (Ag) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 0.0120 | <0.010 | <0.010 | <0.010 |
| Zinc (Zn) | mg/L | N/A | N/A | N/A | 6.1 | 2.6 | 1.8 | 10 | 5.4 | <1.0 |

## EPC

| 24HOURS | | Battery Sludge | | | Munitions Soil | | | Industrial Soil | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | 0.1542 | 0.1238 | 0.114 | N/A | N/A | N/A | N/A | N/A | N/A |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium (Cd) | mg/L | 0.15 | 0.12 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Chromium (Cr) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Lead (Pb) | mg/L | 15 | 11 | 26 | 20 | 9.1 | 4.3 | 29 | 7.4 | 5.4 |
| Mercury (Hg) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Nickel (Ni) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | 0.2 | 0.1 | <0.10 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Silver (Ag) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 0.0101 | <0.010 | <0.010 | <0.010 |
| Zinc (Zn) | mg/L | N/A | N/A | N/A | 6.7 | 3.3 | 1.8 | 12 | 6.2 | 3.1 |

**EPC**

| IMMEDIATE | | BOF Dust | | | Municipal Waste Dust | | |
|---|---|---|---|---|---|---|---|
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | N/A | N/A | N/A | 0.4426 | 0.3432 | 0.3118 |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | 0.0011 | 0.0017 |
| Cadmium (Cd) | mg/L | <0.10 | <0.10 | <0.10 | 22 | 18 | 15 |
| Chromium (Cr) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | | | |
| Lead (Pb) | mg/L | 22 | 16 | 13 | 12 | 20 | 13 |
| Mercury (Hg) | mg/L | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nickel (Ni) | mg/L | <0.10 | <0.10 | <0.10 | 0.65 | 0.57 | 0.44 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Silver (Ag) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Zinc (Zn) | mg/L | 4.6 | 4.9 | 4.7 | 530 | 500 | 370 |

**EPC**

| 24 HOURS | | BOF Dust | | | Municipal Waste Dust | | |
|---|---|---|---|---|---|---|---|
| Property | Units | 10% | 30% | 50% | 10% | 30% | 50% |
| Antimony (Sb) | mg/L | N/A | N/A | N/A | 0.2324 | 0.1238 | 0.2344 |
| Arsenic (As) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Barium (Ba) | mg/L | <5 | <5 | <5 | <5 | <5 | <5 |
| Beryllium (Be) | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium (Cd) | mg/L | <0.10 | <0.10 | <0.10 | 20 | 17 | 14 |
| Chromium (Cr) | mg/L | <0.10 | <0.10 | <0.10 | 0.14 | 0.13 | 0.14 |
| Copper (Cu) | mg/L | N/A | N/A | N/A | | | |
| Lead (Pb) | mg/L | 20 | 14 | 8.1 | 22 | 22 | 24 |
| Mercury (Hg) | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Nickel (Ni) | mg/L | <0.10 | <0.10 | <0.10 | 0.60 | 0.54 | 0.40 |
| Selenium (Se) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Silver (Ag) | mg/L | N/A | N/A | N/A | <0.10 | <0.10 | <0.10 |
| Thallium (Th) | mg/L | N/A | N/A | N/A | N/A | N/A | N/A |
| Vanadium (V) | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Zinc (Zn) | mg/L | 4.1 | 3.9 | 3.5 | 500 | 420 | 300 |

## APPENDIX G

## REVIEW OF HAZARDOUS WASTES

Information Source: Files of Mill Service, Inc.

### Multi-Use Industrial Site Soil

*Source:* This waste is a contaminated soil from a multi-use city industrial site. The site is underlain by artificial fill material consisting of sandy and silty clays, gravelly sands, and clayey sands. The fill debris material consists of bricks, furnace slag, plastic, cloth, decomposed paper, and coal fragments. Due to the artificial nature of the fill material, it appears that the contaminated soil material was mixed with debris from plant operations in the area and placed on the site between 1975 and 1978. No known process within the industrial area generates lead, therefore an off-site source is suspected. Imported fill material was placed on the site and this material is the suspected contaminant source.

*Characteristics:* The waste is a solid, brown in color, and has no odor. The pH range is 7 to 8. The waste exhibits toxicity characteristics for cadmium and lead and also exhibits high levels of total petroleum hydrocarbons (TPH).

*Current Treatment:* The waste is stabilized with lime. If necessary for additional metals control, other chemicals (phosphates, ferrous sulfate) are also used. Upon receipt, the waste is unloaded into a tank and treated. Following treatment, the waste is stored for approximately 24 hours while the efficiency of the treatment process is confirmed. The treated waste is then disposed off-site.

*Waste Availability:* The amount of waste to be treated is 3000 tons. This is one-time only since this is not a continuing process.

### Battery Manufacturing Sludge

*Source:* This waste is a wastewater treatment plant sludge. The waste sludge is generated as a result of treating sulfuric acid wastewater from the production of lead-acid storage batteries and from the operation of a secondary lead smelter. The wastewater is pH adjusted using lime and/or sodium hydroxide. The sludge is collected from a conventional circular clarifier and also from an iron co-precipitation clarifier. Ferrous sulfate is added to the waste stream prior to the iron co-precipitation process. The sludge is then dewatered with a vacuum drum filter.

*Characteristics:* The waste is a solid, off-white to brown in color, and has no odor. The pH range is 6.0 to 9.0. The waste exhibits toxicity characteristics for lead and cadmium.

*Current Treatment:* The waste is slurried with water and lime stabilized to a pH between 9.0 and 12.5 prior to disposal in a surface impoundment which is to be closed as a chemical landfill. If additional metal control is required, soluble phosphate is added to the waste.

*Waste Availability:* The amount of waste to be treated is 6000 tons per year, with a disposal frequency of 450 times per year.

**Basic Oxygen Furnace Air Pollution Control Dust**

*Source:* This waste is basic oxygen shop baghouse dust. The facility is a basic oxygen steel manufacturing facility in which molten iron and scrap along with specific ores are mixed to produce a specific grade of steel. During this operation, the transfer of raw materials and product generate secondary particulate emissions which require capture and disposal. Secondary emissions from a desulfurizer, a slag skimming system, and two production vessels are captured in a baghouse and transferred via screw conveyors to storage in an 80 ton dust silo prior to disposal.

*Characteristics:* The waste is a solid, brownish grey in color, and has a slight metallic odor. The pH range is 9.0 to 12.4. The waste exhibits toxicity characteristics for lead.

*Current Treatment:* The waste is slurried with water and stabilized prior to disposal. Metal control is accomplished with soluble phosphate, ferrous sulfate, lime and/or silicate. Sulfuric acid may also be required for pH control. The treated waste is then disposed of in a surface impoundment which is to be closed as a chemical landfill.

*Waste Availability:* The amount of waste to be treated is 500 tons per year. The treatment frequency is 25 times per year.

**Municipal Waste Incineration Air Pollution Control Ash**

*Source:* This waste is fly ash from a municipal waste incinerator. The plant is a 3-step multiple hearth, two-stage incinerator with fire heat recovery boilers. The ash is collected using a United-McGill electrostatic precipitator. A detailed process schematic is not available at this time.

*Characteristics:* The waste is a solid, powdery, and grey in color. The pH range is 5.3 to 9.8. The waste exhibits toxicity characteristics for cadmium and lead.

*Current Treatment:* Current treatment information is not available at this time.

*Waste Availability:* The amount of waste to be treated is 24 tons per year. The treatment frequency is 4 times per year.

**Sewage Treatment Plant Soil**

*Source:* This waste is a contaminated soil from a former state hospital wastewater treatment plant site. The site was formerly occupied by sewage-drying beds from the plant. It is believed that the contamination resulted from leaching of lead pipes of the former hospital's water and sewage distribution system.

*Characteristics:* The waste is a solid, black in color, and has no noticeable odor. The pH range is 5.5 to 9. The waste exhibits toxicity characteristics for lead.

*Current Treatment:* The waste is stabilized with lime. If necessary for additional metals control, other chemicals (phosphates, ferrous sulfate) are also used. Upon receipt, the waste is unloaded into a tank and treated. Following treatment, the waste is stored for approximately 24 hours while the efficiency of the treatment process is confirmed. The treated waste is then disposed off-site.

*Waste Availability:* The amount of waste to be treated is 490 tons. This is one-time only since this is not a continuing process.

**Munitions Depot Soil**

*Source:* This site is contaminated soil from a former munitions depot. The contamination resulted from storing lead-containing munitions on the site.

*Characteristics:* The waste is a solid, brown in color, and has a soil odor. The pH range is 5 to 9. The waste exhibits toxicity characteristics for lead.

*Current Treatment:* The waste is stabilized with lime. If necessary for additional metals control, other chemicals (phosphates, ferrous sulfate) are also used. Upon receipt, the waste is unloaded into a tank and treated. Following treatment, the waste is stored for approximately 24 hours while the efficiency of the treatment process is confirmed. The treated waste is then disposed off-site.

*Waste Availability:* The amount of waste to be treated is 10,000 tons. This is one-time only since this is not a continuing process.

# APPENDIX H

# CO-7 PROCESS

---------- Forwarded message ----------
Date: Sun, 16 Apr 1995 01:49:00 -0400
From: ALKME@aol.com
To: neufeld@civ.pitt.edu
Subject: Fwd: CO-7 PROCESS TECHNOLOGY ...

To Dr. Ronald D. Neufeld

I would like to sell the manufacturing and or marketing rights for China and or Taiwan. Anything would be helpful.

Thank you,

Donald Munro

---------------------

Forwarded message:
Subj: CO-7 PROCESS TECHNOLOGY PROFILE
Date: 95-04-16 01:21:30 EDT
From: AL K ME
To: enveng-1@cedar.univie.ac.at
CC: AL K ME

The CO-7 technology is a cost effective remediation process for the treatment and stabilization of metals and hydrocarbons in soil or water. The CO-7 PROCESS involves introducing a proprietary combination of reagents into the contaminated material with intimate mixing, then establishing theoptimum conditions for allowing the desired reactions to occur.

Ingredients in the CO-7 reagent will react with toxins in solid hazardouswastes, either converting them to leach-resistant insoluble forms or by sealing them within an insoluble matrix. CO-7 will react with polyvalent metal contaminants to form insoluble metal compounds that are resistant to leachants over a broad ph range. The end result is a more chemically stable non-toxic material with improved physical characteristics.

A major constituent of the CO-7 reagent is a proprietary blend of soluble silicates which allows for the effective immobilization of soluble metal toxins by reacting with them to form insoluble matal silicates. Soluble silicates are a unique class of polymeric compounds in which sodium oxide ($NA_2O$) is associated with silicon dioxide ($SIO_2$), generally in ratios varing from 1:1 to 1:3.22. The more polymeric, high ratio, soluble silicates are favored in soil remediation applications. These depolymerize in dilute solutions to form chains of silica and oxygen with hegative chargews on some of the oxygen atoms. These negative sites react with metal ions having positive charges to form stable, insoluble metal silicates:

```
         O-    O-                                    O--M--O
          I     I                                      I         I
  -O--Si-O--Si-O-    +     M++  = -O-Si--O--Si-O
```

For example, the reaction between a soluble metal salt such as lead sulfate and a soluble silicate will produce insoluble lead silicate and the innocuous soluble sodium sulfate:

$Na_2O:SiO$ + $PbSO_4$ = $PbSiO_3$ + Na $So_4$
sodium silicate + lead sulfate = lead silicate + sodium sulfate

Having been rendered insoluble in the form of a silicate, the hazardous metal is fixed in place and cannot leach out to contaminate theaquifer. As the treated mass cures and dries, a crumbly, non-hazardous coarse powder results which is easy to handle and ideally suited for construction or landfill applications. Analysis of treated materials which were formerly hazardous has repeatedly shown them to be in compliance with various regulatory standards as non-toxic products.

Treatment of volatile organic contaminants is equally effective when the CO-7 process is employed. With respect to petroleum hydrocarbons and the more complex organic contaminants such as PCB, TCE, PCE, etc., the mechanism at work appears to be a combination of hydrolyzing the hydrocarbons into reactive fractions which bond with some of the CO-7 ingredients to form a chemically altered and stable insoluble crystalline silicate structure, and the formation on the particulate level of a protective coating of an insoluble sisicate matrix. The insoluble matrix results from the reaction of sodium silicate with naturally occuring calcium oxides or hydroxides in the soil to produce insoluble gel matrixes of calcium silicate:

$Ca(OH)2 \quad + \quad NA2O{:}SiO2 \quad = \quad CaO{:}SiO2 \quad + \quad 2NaOH$

calcium hydroxide + sodium silicate = calcium silicate + sodium hydroxide

$CaO \quad + \quad Na2O{:}SiO2 \quad = \quad CaO{:}SiO2 \quad + \quad Na2O$

calcium oxide + sodium silicate = calcium silicate + sodium oxide

The formation of insoluble calcium silicate gel acts to encapsulate and fix in place both organic and inorganic contaminates, resulting in a stabilized non-hazardous waste from which toxins cannot leach out. Treatments with the CO-7 PROCESS have resulted in dramatic reductions in leachable petroleum hydrocarbons and complex organics which have been documented - without the release of organic off-gas emissions.

Some of the important features of the CO-7 PROCESS technology are summarized as follows:

1. The proprietary reagent and other ingredients are custom blended to optimize efficient treatment, achieving one of the most cost effective methodologies available.
2.Only relatively small increase in volum typically occur in the treated materials.
3. Treated materials are non-combustible, non-toxic, non-hazardous and essentially odorless.
4. The CO-7 PROCESS can be used with a wide variety of environmental contaminates and in many environmental applications, including volatile organics and metals in soils, sludges and waste water.
5. Treated materials are in compliance with regulatory standards for non-hazardous materials, so that soils may be backfilled after curing, eliminating the need for further disposal.
6. The use of the CO-7 PROCESS technology is straight forward and amenable to mobile systems allowing for quick on-site set up time and high volume throughput or be recycled for other usage.
7. Advantages of the CO-7 Process for contaminate remediation and stabilization have been well documented and it is considered to be a "BEST AVAILABLE TECHNOLOGY" in most situations involving volatile organic or metal contaminated site remediation.

Donald Munro
133 Reynoir Street
Biloxi, MS 39530
USA

or

ALKME@AOL.COM

## APPENDIX I

## REPORTS OF MEETINGS, TELEPHONE CONVERSATIONS AND VISITS

### RECORD OF TELEPHONE CONVERSATIONS
### FEBRUARY 21-22, 1995

Thomas King (CSX)

Mr. King has received the material which Dr. Cobb sent on February 9, 1995 (a letter requesting approval for use of the AES Thames by-product which provides background, explanation and a copy of the first quarterly report). He confirms that Mr. Dobbins has also.

Mr. King has discussed our project with Mr. Dobbins. Both CSX and JTM are comfortable with it provided that AES Thames gives its approval. He has left a voice-mail message with Mr. Boucher and will speak with him soon about it. Dr. Cobb indicated that he also will call Mr. Boucher soon.

Mr. King reported that JTM is placing much effort into its new work for AES Thames and Mr. Boucher is devoting much time to this also. It had been hoped to be through with this major effort by now but it appears that the heavy work will continue through March. Our proposal may be difficult to deal with until this other work is finished.

Joel Beeghly

The 50-ton Phase Two sample was transferred from the silo at Tidd into two pneumatic tanker trucks yesterday morning (February 21, 1995). The by-product was at 270°F. Each truck required eight minutes to fill. Yesterday afternoon the trucks were driven to Aimcor in Aurora, Indiana where they were unloaded this morning to a silo. Donald Kerrivan of DLC will observe the bagging this afternoon. After the super-sacks are filled, two flatbed trucks will bring them to Neville Island. Dr. Cobb will prepare a letter of assurance for DLC that the Phase Two sample from Tidd will be removed from Neville Island before the project is concluded. The cost of collecting the Phase Two sample will be increased by about $500 to cover out-of-pocket expenses incurred by DLC.

### RECORD OF MEETING
### FEBRUARY 27, 1995
### DRAVO LIME COMPANY, NEVILLE ISLAND

Present: James Cobb, Joel Beeghly, Steven Tutokey and William Carlson

A list of Phase One samples already collected was reviewed. It was noted that a second sample of the Tidd by-product was sent to MSI at their request because the size of the first sample sent there was too small. No further samples will be sent to MSI's Yukon Plant during Phase One.

DLC has much experience with the Tidd by-product. Mr. Beeghly expects it to be an excellent material for this project. He suggested that the mixed ratio for this material is not indicative of its final set strength, which is very good. The fineness may contribute to this disparity. DLC bases this expectation also on their past experience with both coal-fired and petroleum coke-fired CFBCs, on discussions with Patriot Mining Company and on information in the literature.

Mr. Beeghly noted that a number of coal-fired power plants in the western U.S. have spray drier sulfur dioxide removal while the Carneys Point facility is the first one in the east.

Mr. Beeghly suggested that the project team examine the "barriers report" and the book by Jesse Conner as background on waste stabilization as it relates to the role of this project.

Aspects of the analyses of by-product at DLC and Pitt were discussed. Mr. Carlson suggested that in preparing spiked samples in the QA/QC for digestions for total metals, spiking is done before digestion. This is especially important for chromium which tends to volatilize. The chemical composition will be reported as the oxide form - CaO, MgO, $SiO_2$, $Al_2O_3$, etc. The "total" of these components, as a result, may be somewhat different from 100.0%. It was agreed that the mineralogy should be examined to seek the "active" components of the by-products - lime, anhydrate, silica/alumina pozzalan, sulfo-pozzalan, etc. The "glassiness" of alumina should also be examined. One outcome of this search would be suggestions, if necessary, for cofactors (ingredients) to use for stabilization along with the by-products.

It was agreed that extensive discussion of analytical results of by-products will be delayed until the third quarterly report when most of the analyses will have been conducted.

RECORD OF MEETING
MARCH 1, 1995
1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Emanuel Schreiber, Vourneen Clifford and Jesse Pritts

Laboratory Work

Regarding the TCLP extractions of by-products, it was noted that the extracts are very alkaline, even though the stronger extraction fluid was used (based upon appropriate testing before extraction). The spiked samples before extraction are not returning the added metals because of this alkalinity. When spiked samples of the acidified extract are prepared, the added metals should remain in solution. This would be an appropriate issue to discuss with North Dakota and Iowa. Data obtained to date will be tabulated for inclusion in the second quarterly report.

Regarding digestions, samples of digestates of four hazardous wastes were obtained yesterday (February 23, 1995) from MSI. Antech, which supplied these four digestates to MSI, has also digested the four by-products but did not supply digestate to MSI. Antech has done ICP analyses for eleven metals on digestates of both wastes and by-products. Pitt will do graphite furnace analyses for four additional metals on the waste digestates. It will also digest the by-products itself to obtain digestate for analysis for the four additional metals. Before doing the graphite furnace work with the waste digestates, Ms. Clifford and Mr. Pritts will check with Antech to make sure that a non-chloride-based acid was used to neutralize the digested solid mass. Chlorides of some metals, including one of the four additional ones, are volatile.

MSI Subcontract

Dr. Cobb will contact MSI to discuss these analyses and to obtain information for the second quarterly report. Mr. Bender has sent several memoranda recently to report on MSI's progress and to seek coordination on analyses for decision-making. Copies of these memos and the list of samples and analyses acquired by DLC were distributed.

Public Relations

Dr. Cobb described the draft news release and newsletter article being prepared by Pitt's public relations staff.

Background Review

The two white papers being prepared by Ms. Clifford and Mr. Pritts were discussed.

## RECORD OF TELEPHONE CONVERSATIONS
## MARCH 1-3, 1995

Mark Boucher (AES Thames)

Mr. Boucher indicated that, because CSX owns the ash after it leaves the AES Thames plant, CSX should indemnify AES Thames by a letter, which will be placed on file. Mr. Boucher feels that JTM needs to be involved somehow in the discussions and clearances. A letter of approval to use the by-product would be issued by CSX.

Carl Bender

Digestions for total metals analyses were discussed. Pitt would like to use Antech's digestates as much as possible, but is concerned that they may not be suitable for some metals needing analysis by the graphite furnace method. Mr. Bender suggested calling Edward Kifer at Antech to discuss this.

Mr. Bender has established the specific procedure for laboratory stabilization of the five suitable wastes, Carol Kiselich has conducted their stabilizations with the three approved by-products and the TCLP extracts of the stabilized test samples have been sent to Antech. Results are expected back March 10, 1995. After reviewing the results, discussions will be held on the recipes for the treatment batches from which the solidification samples (cylinders) will be made.

Mr. Bender will give consideration to the disposal of unused by-product remaining at the conclusion of the project. One possibility is returning the material to the originators.

Mr. Bender will begin preparing the MSI portion of the second quarterly report.

Thomas King (CSX)

CSX sees no necessity, advantage or profit to having the AES Thames ash tested in this project. In addition, AES Thames' desire for indemnification would require an extensive examination of all possible outcomes and a detailed presentation by CSX. Dr. Cobb agreed to give more thought to this and offer suggestions. One possibility is MSI or Pitt providing indemnification to CSX.

Mr. King expressed concern that the record of conversations with him in the first quarterly report contained inaccuracies. He recommended the following corrections:

- ERL (of CSX) began its contract with AES Thames in the 1980s.
- AES Thames has numerous contracts in force.
- CSX's contract calls for it to supply coal and limestone to the plant and remove ash from it.
- AES Thames as generator of the ash is ultimately responsible for its proper disposal in a non-hazardous manner.
- CSX has contracted with JTM for ash management; thus JTM has a role in all ash disposal decisions.
- The relationship of CSX with Patriot Mining Company has been constant from the beginning of the contract to dispose ash at the Albright Mine; any other use of the ash beside placement at the Albright site requires approval of CSX and AES Thames. It was noted, however, that Pitt sought approval from the Patriot Mining Company to use the by-product in a more "relaxed" period before JTM's recent intense activity as ash manager for CSX for the AES Thames ash.
- The two sentences on Page 37 of the first quarterly report concerning American Electric Power Company (AEP) could not have originated with CSX.
- Under JTM's contract with CSX, JTM can transfer the AES Thames ash by other carriers than CSX in rolling stock owned by others (including JTM itself).
- AES Thames retains the right to disapprove any ash management approach suggested by CSX or JTM (through CSX).
- Again on Page 37 of the first quarterly report, no reference would ever have been made to the current use of AES Thames ash "for treatment of hazardous waste;" it has never been so used.

Joel Beeghly

Dr. Cobb described his recent conversations with Mr. Boucher and Mr. King and asked him for his thoughts. Mr. Beeghly made the following observations:

- The "barriers report" relates to this; Mr. Tyson of ACAA certainly would have some thoughts about this; Mr. Bedick of METC discussed the "barriers report" at the recent ACAA meeting in Orlando, Florida.

- Possibly the project could get immediate approval for use of the AES Thames ash just for Phase One; approval for Phase Two could be sought later.

- The AES Thames ash appears to be a very useful by-product, judging from the first laboratory evaluations by DLC.

- Coal-fired CFBC by-product from a unit in Detroit in-house is being used by the by-product producer to treat characteristic chrome-laden hazardous waste; JTM has had association with this producer and may already have served as ash manager for use of coal-fired CFBC by-product to treat characteristic metal-laden hazardous waste.

- Possibly a member of the law faculty at Pitt might have some thoughts about this situation.

Steven Bossart

Dr. Cobb described his recent conversations with Mr. Boucher, Mr. King and Mr. Beeghly. Mr. Bossart advised not to use any by-product in Phase One that has not been approved for Phase Two as well. He recommended drawing the search for approval to an end as soon as possible and shift to another by-product if approval cannot be obtained. The Airpol by-product would appear to be a good alternate.

RECORD OF MEETING
MARCH 8, 1995
1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Ronald Neufeld and Vourneen Clifford

Laboratory Work

Ms. Clifford and Mr. Pritts are having difficulty preparing the antimony standard. The metal they are starting with won't dissolve in either nitric or hydrochloric acid. Another student, who is trying to make a vanadium standard, is having similar difficulty dissolving vanadium pentoxide. It was agreed to purchase both standard solutions.

Dr. Neufeld will begin to examine the data flowing form the project to establish the best approach to organizing the spreadsheets.

Background

Dr. Neufeld has just been involved in reviewing proposed new regulations for central waste treaters. The project team should examine them to determine if any of their procedures should be modified to reflect these potential requirements.

Dr. Neufeld observed that the EPA is examining cost/benefit relationships on the basis of "cost of removal per pound toxic equivalent." The project team should examine this methodology also.

The project team should contact investigators from Iowa State, North Dakota, EEI, EPRI, ACAA, EPA, NIST, DOD and PADER for general advice.

By-Products

Dr. Cobb reported on his recent conversations regarding the AES Thames by-product.

## RECORD OF TELEPHONE CONVERSATIONS
## MARCH 9-14, 1995

Joel Beeghly

The final sample from Tidd has been collected, as well as two more at CONSOL. All samples are in from Ebensburg Power Company and Anker Energy. Frank Theodore is working toward obtaining records of operations at Carneys Point. Dr. Cobb will talk with the plant manager at Tidd to obtain operating records there.

Mr. Beeghly reiterated his suggestion to speak with ACAA regarding the possibility of their assistance in seeking approval for use of the AES Thames by-product.

Terrence Coyne (Pitt)

Mr. Coyne, a staff member of the Office of Research, will explore the possibility of indemnification of CSX by Pitt.

Carl Bender

Mr. Bender recalls that MSI has occasionally provided indemnification for a hazardous waste producer but never for a treatment chemical supplier. The normal manifest system for hazardous waste establishes a clear chain-of-custody which shows the cradle-to-grave history of the waste. In such an environment, indemnification might be a moot point. Mr. Bender will speak with Philip Costantini, MSI's vice president for business, who deals with MSI's legal issues.

Thomas Blackstock (ACAA)

Mr. Blackstock confirmed that electric utilities generally have been very reluctant to have their ashes used for "treatment" of hazardous wastes. He is unfamiliar with the practice of other industrial sectors (lime, cement, etc.) of selling their residuals for this purpose. He will speak with Mr. Tyson and both will give Dr. Cobb more information about this issue.

Philip Costantini (MSI)

MSI never indemnifies hazardous waste producers, who are responsible from cradle-to-grave. Because there is no public record of the purchase and use of treatment chemicals, there is no possibility of legal entanglement to their providers. The treated waste is solely the responsibility of the waste treater and the repository operator. MSI could provide a letter to a treatment chemical producer explaining this. Mr. Costantini emphasized that treatment chemicals are generic items of commerce. Even if they are not the main product of another process, they are useful, marketable, saleable by-products - not wastes.

RECORD OF MEETING
MARCH 15, 1995
1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Ronald Neufeld, Emanuel Schreiber, Vourneen Clifford and Jesse Pritts

News Releases

Dr. Cobb reported that work is progressing on preparation of a Pitt news release and an article for the April newsletter of the School of Engineering.

Second Quarterly Report

The Pitt data on by-products and wastes for reporting for the second quarter need only be on one special spreadsheet. Dr. Neufeld will work with Ms. Clifford and Mr. Pritts to set up the report table appropriately. Footers will be used to record special information needed on the printout of the spreadsheet. There will be no detailed data analysis in this document.

The report will not include any QA/QC data, nor will any future report. The QA/QC data will be held in an internal report only. Dr. Cobb asked for a brief general writeup on QA/QC for the quarterly report.

Data Base

The full spreadsheet for the project was discussed. It should have in it data from DLC, MSI and Pitt on digestate analyses, leachate analyses and compressive strength measurements. This is expected to be a large (2 MEG) file. It was suggested that consideration be given to including a disk with all the data in the final report. Using Quatropro will allow numerous sub-files and templates to be developed to produce graphical displays for evaluation. Ms. Clifford and Mr. Pritts have the manual for this software. Dr. Neufeld suggested they contact Mr. Daniel Gelman, a recent graduate, who has worked extensively with Quatropro.

A sample identification code needs to be set up for the data base. Dr. Schreiber will work with Ms. Clifford and Mr. Pritts to establish one.

Laboratory Work

An extensive discussion was held concerning detection limits. In order of increasing sensitivity are ICP, flame AA and graphite furnace. There are two detection limits - (1) the absolute one based upon the lowest observable signal from the instrument and (2) the instrumental one based upon the lowest calibration value. For this project it was determined that ICP was sufficient for most metal analyses (see Test Plan) but that the four additional metals would have to be measured by graphite furnace and certain by-product metals would be measured by flame AA, which is the standard method at Pitt. The detection limit can vary for a given metal as a function of interferences ("chemical noise") from other components in the sample.

Work with the graphite furnace is being held up while the two standards are being awaited and the film in the autosampler is being fixed.

Background

Dr. Neufeld distributed a document from the Federal Register on the proposed new regulations for central waste treaters that he mentioned in the last group meeting on March 8, 1995.

By-Products

Dr. Cobb reviewed his recent discussions regarding the AES Thames by-product.

RECORD OF TELEPHONE CONVERSATIONS
MARCH 27, 1995

Carol Rose (EEI)

An ASTM committee is working to develop standards for treating hazardous wastes with by-products. Both James Roewer of EEI and Deborah Hassett of UNDEERC are deeply involved with the work of this committee.

Samuel Tyson (ACAA)

UNDEERC provides general technical information to ACAA. ACAA will publish a survey on waste stabilization this month by Kurt Island of UNDEERC.

ACAA is working with EEI to limit the liability required of by-product producers.

The ASTM committee developing standards for treating hazardous wastes sees the need for Federal legislation to block the assignment of liability to by-product producers providing treatment chemicals to Superfund sites.

JTM is now owned by Laidlow Environmental Services of Columbia, SC.

RECORD OF MEETING
MARCH 29, 1995
1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Ronald Neufeld, Emanuel Schreiber, Vourneen Clifford and Jesse Pritts

Laboratory Work

The thallium standard has been received. We are still awaiting the antimony and vanadium standards. Ms. Clifford and Mr. Pritts will check on the purchase order for the two standards not yet received. If there is a problem with the purchase order, they will walk the paperwork through and pick up the standards directly from the supplier.

Sketches of database pages, proposed by Mr. Pritts, were reviewed and approved. Most of the reports will be bar charts, probably in three dimensions. Dr. Cobb will contact Mr. Bender at MSI to find out what data MSI has that can now be added into the database.

Pittsburgh city drinking water is to be used as a benchmark.

The QA/QC methodology was discussed briefly. The date and time of all QA/QC analyses will be carefully recorded so that all analyses covered by each QA/QC sample can easily be identified.

Fourth By-Product

Dr. Cobb brought the group up-to-date on the AES Thames situation. It was suggested that we ask METC to request a sample for study and evaluation. Dr. Neufeld will contact Dean Golden at EPRI to ask his advice on this matter. Dr. Cobb will once more speak with Mr. Boucher to determine if AES Thames will provide an research sample to Pitt outside of the CSX channel.

RECORD OF MEETING
APRIL 5, 1995
1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Emanuel Schreiber, Vourneen Clifford and Jesse Pritts

Laboratory Work

The last standard has been received and analysis for the four additional metals by graphite furnace is ready to proceed. Mr. Latona will help Ms. Clifford and Mr. Pritts tomorrow to initiate this method. At Dr. Schreiber's suggestion they will check today to make sure the modifier for the vanadium analysis is available.

Several digestions were conducted yesterday. All total digestions have been completed (five wastes and four by-products). Fourteen TCLP extracts are also ready for the graphite furnace method.

Treatment Method

The sequence of events to decide on the treatment method to use for each waste/by-product set was reviewed once again. The need for the analyses for the four additional metals in the total digestate to determine if any are required for the TCLP extractions of the three samples for each set was discussed. Analysis of TCLP extracts for metals which cannot exceed 100xDW even if totally dissolved will not be needed. All acceptable recipes must stabilize all metals, including any of the four additional ones that could possibly be significant.

RECORD OF TELEPHONE CONVERSATIONS
APRIL 5, 1995

Mark Boucher (AES Thames)

AES Thames by contract provides its ash to CSX. CSX may consider it either a waste or a product if they wish, but the numerous banks that have provided financing to AES Thames all want ash disposition done in accordance with the contract. Any deviations from the contract (and there have been some) must receive the approval of over 51% of the financial holders, but this is a lengthy, involved process.

Mr. Boucher reiterated that full indemnification by Pitt or MSI would be the easiest way to meet AES Thames need.

Mr. Boucher agreed to speak to the environmental and legal staffs of AES Thames about relaxation of indemnification by considering ash as a commercial product rather than a waste. He will also pass this by the new plant manager who takes over on Monday, April 10, 1995. After these conversations, he will let Dr. Cobb know their outcome.

Mr. Boucher also suggested that JTM could indemnify CSX. He suggested that Dr. Cobb speak to Mr. Dobbins about this.

Grover Dobbins (JTM)

Mr. Dobbins agreed that if the financial holders of AES Thames have to provide approval for use of AES Thames by-product, the approval process is difficult. He will speak with Mr. King of CSX to see if JTM can do anything to get approval for the project.

David Chester is JTM's on-site manager at AES Thames. He will have information about each railcar that was loaded at the plant. In loading, the car first receives a layer of foam, then bed ash, then fly ash on top, although sometimes fly ash is omitted and bed ash fills to the top. Bed ash is the most active, fly ash is less so. Mr. Dobbins suggests getting a fresh sample from the plant directly, to use in the laboratory treatment studies.

Carl Bender

Mr. Bender is finishing a LOTUS spreadsheet to include all data collected so far on the six wastes, three by-products and forty-five treatments. He will send this to Pitt early next week.

Dr. Cobb agreed to ask Ms. Clifford and Mr. Pritts about their assistance at Yukon in cylinder production.

RECORD OF MEETING
APRIL 12, 1995
1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Ronald Neufeld, Emanuel Schreiber, Vourneen Clifford and Jesse Pritts

Laboratory Work

The total beryllium and antimony, and the TCLP concentrations of these two metals for the four by-products and five wastes were reviewed. A thallium lamp is needed to complete the work with that metal.

The possibility of several undergraduates joining the project team for the summer was discussed. It was agreed that two additions would be appropriate - an undergraduate as an hourly employee and another undergraduate from the Research Experience as Undergraduate Program of the Chemical & Petroleum Engineering Department be added.

Miscellaneous

Dr. Cobb reviewed his recent discussions with AES Thames, CSX and JTM. He reminded the group that a progress report is due on May 18, 1995 as part of the request for Phase II funding. He also noted that the request for NETAC's environmental assessment activity to start on June 18, 1995 is due also on May 18, 1995.

RECORD OF MEETING
APRIL 19, 1995
1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Ronald Neufeld, Emanuel Schreiber, Vourneen Clifford, Jesse Pritts and Jana Agostini

Laboratory Work

Ms. Agostini was introduced as the summer hourly undergraduate employee. She will begin work on May 15, 1995 and be with the group through August 15, 1995.

The vanadium data has been obtained on the nine digestate samples. The thallium lamp was ordered last Tuesday. It still has not arrived. Dr. Schreiber will check to see what the delay is. The ASTM extracts of the four by-products (two extracts each) are being analyzed for all 15 metals. The silver lamp failed about half-way through analyses for that metal. Another lamp will be purchased.

It was agreed that all samples will be kept until the project has been completed.

Dr. Neufeld reported that several messages have appeared recently on the e-mail environmental bulletin board regarding the solid residues left during digestion for total metals analyses. The antimony results presented last week (no antimony in the digestate but significant antimony in the TCLP extract) raises serious questions. The group agreed to continue examining this issue over the coming months.

Background

Dr. Cobb reported that, in a discussion on another subject with James Roewer of Edison Electric Institute earlier in the week, he had mentioned the difficulty the group is having in obtaining approval for use of the AES Thames by-product. Mr. Roewer indicated much dismay at this situation, especially since this is an R&D project. He is trying generally to get the utilities to be more open in this area.

Mr. Pritts reported that he has received from EPA FR 55 (61) Thursday, March 29, 1990, 11798-11877, 40 CFR Part 261 et al., Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule.

Dr. Neufeld asked Dr. Cobb to find out if Mr. Bender has received the material on central waste treatment that Dr. Neufeld sent to him recently. Specifically, Dr. Cobb should ask Mr. Bender if anything in this material would cause the group to alter its activities.

RECORD OF TELEPHONE CONVERSATION
APRIL 19, 1995

Joel Beeghly

AES at one time supplied Chem Waste's Sulfur, Louisiana Plant (near Lake Charles) with FBC ash by barge from the Shady Point Plant on the Arkansas/Oklahoma line. Mr. Beeghly recalls that AES received $20/ton for this treatment chemical for hazardous waste stabilization. AES has at least a half dozen plants around the U.S. The Chem Waste Sulfur Plant switched to another by-product some time ago.

## RECORD OF TELEPHONE CONVERSATION
## APRIL 21, 1995

Grover Dobbins (JTM)

JTM is prepared to support the project if AES Thames provides a letter approving the use of its by-product in it. CSX then would have no real role and has no concern about it one way or the other. Dr. Cobb agreed to call Mr. Boucher about this.

Two points of information were noted. AES maintains a small corporate office in Fairfax, Virginia. JTM markets the AES Shady Point by-product out of its southwest regional office.

Mark Boucher (AES Thames)

The environmental and legal staffs of AES Thames insist that CSX must provide indemnification for any use of the by-product under terms of its contract. Dr. Cobb noted that he will recommend to the project team and the COR to remove the AES Thames by-product as the fourth treatment chemical.

One point of information was noted. Should the project team desire to talk to the manager and staff of the AES Shady Point Plant, the telephone number is (918) 962-9451.

Joel Beeghly

Alternatives to the AES Thames by-products, in order of decreasing preference, are (1) the by-product of an Ohio coal-fired FBC, marketed by JTM's midwestern regional office in Dayton, Ohio (contact: Mr. Bruce Boggs, 513-291-0707) and being used on another project by DLC (which already has six analyses of the material); (2) another eastern coal-fired FBC material marketed by the midwestern regional office of JTM; (3) the western coal-fired FBC material from the AES Shady Point Plant; (4) the Airpol by-product.

Stephen Bossart

On April 10, 1995 Jason Lewis was assigned to be COR for our project.

Jason Lewis

Mr. Lewis agrees with the list of priorities for the new fourth by-product which Dr. Cobb developed with Mr. Beeghly.

## RECORD OF MEETING
## APRIL 27, 1995
## 1139 BENEDUM ENGINEERING HALL

Present: James Cobb, Emanuel Schreiber, Vourneen Clifford and Jesse Pritts

Laboratory Work

Analyses for the four metals (antimony, beryllium, thallium and vanadium) for the nine digestates has been completed. Ms. Clifford will send the results to MSI and Dr. Cobb will send them to DLC. The results of analyses for the by-products, wastes and fifteen treated wastes were mailed on Monday from MSI and should arrive today. Dr. Cobb will send them to DLC.

The group thoroughly discussed the role of the TCLP extraction in the definition and regulation of hazardous waste. It also reviewed once again the analyses required to decide on the final recipe for each waste/by-product set.

Mr. Pritts will visit the MSI Yukon Plant to pick up the 45 TCLP extracts for analysis for the four extra metals.

Background

Dr. Cobb reported on the discussions which led to the elimination of the AES Thames by-product as the fourth material for testing in our project and the steps to be taken in seeking its replacement.

Database

Ms. Clifford reported that a virus found recently in the PCs of the Civil and Environmental Engineering Department has delayed the development of the database momentarily. The virus is being removed and work will resume shortly.

## RECORD OF TELEPHONE CONVERSATIONS
## MAY 1, 1995

Joel Beeghly

Mr. Beeghly made the following suggestions for persons to contact in regard to stabilization of hazardous metals - (1) Deborah Hassett at UNDEERC, (2) David Hassett at UNDEERC, Albert Bland at WRI, (4) someone at Lawrence Livermore - known to Samuel Traina at Ohio State, (5) the person at JTM's Dayton office whom I am to call about the GM by-product, and (6) either Michael Gillam or Roger Spence at Martin Marietta's Oak Ridge National Laboratory operation. He also suggested looking into Jesse Conner's book.

Audrey Zelanko

Dr. Cobb reviewed the status of the project and agreed to find out soon from Mr. Lewis what is required to request initiation of the Environmental Assessment of Phase II.

RECORD OF MEETING
MAY 4, 1995
MILL SERVICE, INC. - SOUTH HILLS OFFICE

Present: James Cobb, Ronald Neufeld, Carl Bender, Philip Costantini and Jesse Pritts

It was agreed that the by-products from the Ebensburg Power Company and the Tidd Station did not immediately stabilize lead in any of the hazardous wastes tested. Mr. Bender noted, however, that to stabilize lead-containing wastes MSI normally uses an additive containing the phosphate ion (the use of which is reported in Conner's book as the usual second ingredient in a lime-based hazardous waste treatment).

Dr. Cobb noted that a report supplied by Mr. Beeghly showed that portland cement-based stabilizers (and by inference pozzolanic stabilizers) tie up lead much more slowly that the lime-based stabilizers. Thus, it is not surprising that the EPC and Tidd materials were immediately unsuccessful. Stabilization over a longer time should be explored with these materials. Mr. Bender noted that MSI as a commercial treater cannot economically utilize such slow stabilizers, because it cannot afford to store the treated material more than the one day required to run a TCLP on the immediate product of stabilization. [The TCLP extraction requires 18 hours and the metals analysis requires six hours.]

The by-product from CONSOL immediately stabilized the lead in the more acidic wastes (containing hydroxides, sulfates, etc.) surprisingly well, even without the phosphate-containing additive. In fact, it exceeded current regulations far enough to even exceed what is expected to be the LANDBAN regulations. However, it did not perform well with the more highly oxidized materials. Mr. Bender will calculate the price that MSI would be able to pay for the CONSOL by-product FOB the Yukon Plant, if it were used in the best recipe found to date for lead stabilization.

Mr. Bender noted that cadmium is much harder to control. The CONSOL by-product was not able to stabilize that metal effectively by itself.

The lower pH values of the treated materials is not a problem - they are well above the lower limit for residual (non-hazardous) landfills. Some samples of the original by-products do, however, exceed the upper limit of 12.5.

The results reported by MSI do not include the amount of water used. Mr. Bender will add this information to his spreadsheet. Usually the amount of water used renders the treated waste crumbly although sometimes enough is used to render it pasty. Landfills have criteria for the lower limit on percent solids allowable to a fill, but no requirement for solidification. [At one time there was a 50 psi requirement, but that has been eliminated.] A fundamental question is - when does stabilization occur? Does it occur when the waste is treated (when it has little water associated with it) or does it occur when the material is placed in the TCLP solution?

Mr. Bender noted that the extraction fluid varies. The fluid labeled #1 is less aggressive and that labeled #2 is more aggressive. In evaluating commercial treatments, MSI never uses Fluid

#1, always Fluid #2. For some of the CONSOL-treated materials, Fluid #1 was specified by the preliminary test, which is a very unusual situation.

Mr. Bender passed out a special spreadsheet showing the stabilization due to dilution only. It was clear that chemical stabilization is playing the major role for the CONSOL by-product.

The group reviewed the results of the Pitt analyses of the waste and by-product digestates for the four extra metals. It was agreed that beryllium and vanadium must be analyzed for all treated samples, antimony must be examined for a few samples and thallium may be neglected. Mr. Pritts will go this afternoon to the Yukon Plant to pick up the 45 TCLP extracts of treated samples for analysis at Pitt for beryllium, vanadium and (for several samples) antimony.

It was agreed that consideration should be given to conducting the following tests (in place of some others that are currently in the Test Plan):

- redoing the treatments of the BOF and MSW incinerator wastes using the CONSOL by-product with additives containing the phosphate ion;
- treat several of the acidic wastes with currently-used waste lime <u>without phosphate-containing additives</u> for comparison with the use of CONSOL by-product without phosphate-containing additives;
- treat several of the acidic wastes with the CONSOL by-product at lower levels (below 10%) and with phosphate-containing additives (2-5%).

In order to initiate the solidification portion of the project, it was agreed that the project team will produce as soon as possible the cylinders using the four successful treatments with 1:9::CONSOL by-product:waste.

Dr. Cobb will prepare the minutes of this meeting. Mr. Bender will review all of the results and will provide a set of conclusions (in bullet form).

## RECORD OF TELEPHONE CONVERSATIONS
## MAY 6, 1995

<u>Bruce Boggs (JTM - Dayton)</u>

Dr. Cobb explained the project, its need for a fourth by-product and the assistance requested of JTM's midwestern office. Mr. Bogg's agreed to review several of the contracts currently being managed from that office. He has just relocated there from JTM's western office, so he is unfamiliar as yet with their contents. He asked if the project needed an eastern by-product or could utilize one from the west. Dr. Cobb indicated that a western by-product would be acceptable.

Dr. Cobb agreed to send Mr. Boggs by overnight express copies of the Test Plan and the first two Quarterly Reports for the project.

Joel Beeghly

If JTM is unable to provide the fourth by-product, ash from the Pyropower unit at the Fort Dunn Plant might be sought. Mr. Beeghly can put the project team in touch with several individuals with whom the availability of this material can be explored. This by-product has been marketed as a treatment chemical and described in a paper at the recent meeting of the American Coal Ash Association.

RECORD OF TELEPHONE CONVERSATION
MAY 9, 1995

Jason Lewis

Dr. Cobb reported on the success with the CONSOL by-product and the continuing search for the fourth by-product.

Dr. Cobb and Mr. Lewis then discussed the format for the request to begin the environmental assessment of Phase II and for the request to begin Phase II and the progress report to accompany it.

Dr. Cobb and Mr. Lewis also agreed to set up a visit of Mr. Bossart and Mr. Lewis to the Yukon Plant to review the project and provide an orderly transfer from the former to the present COR.

RECORD OF MEETING
MAY 11, 1995
1139 BENEDUM HALL

Present: James Cobb, Ronald Neufeld, Emanuel Schreiber, Vourneen Clifford and Jesse Pritts

Report

Dr. Cobb reported that the regional manager of JTM Industries' midwestern office is reviewing contracts in his area to try to identify a by-product from a coal-fired FBC for our project. Dr. Cobb also reported that the issuance of the letter authorizing the NEPA evaluation of Phase Two will be quickly accomplished upon receipt of the Continuation Application.

Continuation Application

The group then discussed the format and content of the Continuation Application. Particular attention should be paid to the ideas that were developed during and as a result of the May 4 meeting at MSI.

Student Research

The project team will add two undergraduates for the summer - one as a general hire from Pitt and one assigned from a special program in the Chemical & Petroleum Engineering Department, the Research Experience for Undergraduates Program, sponsored by the National Science Foundation. Several research ideas for both the undergraduates and the graduate student researchers are:

- study the rate of stabilization to distinguish between the rapid stabilization of the spray drier by-product and the slow stabilization of the FBC by-products.

- study the enhancement of stabilization by phosphates, including predictions from computerized thermodynamics programs.

- study the rate of solidification.

- study the anomaly that antimony is not present in the digestate but does appear in the TCLP extract for the EPC and Tidd by-products.

Ms. Clifford and Mr. Pritts will develop a one-page prospectus for each of their thesis topics.

Laboratory Work

Approximately two-thirds of the by-products received at Pitt have been digested. After the remaining one-third have been digested, all digestates prepared by Pitt will be analyzed for all metals here at Pitt.

Ms. Clifford and Mr. Pritts have placed some data in a Quatropro file but they have not as yet set up the button designations to use in cross-plotting and analyzing the data. They will work with Prof. Neufeld to set these up.

Treatments

As a result of the meeting last week at MSI it was agreed to begin considering two additional avenues of investigation: (1) modify the treatments with CONSOL by-products to reduce the amount of by-product and introduce additives, such as the phosphate ion, and (2) examine a soil-like, compacted form (as distinguished from concrete or grout) to use in structural fills, especially for the EPC and Tidd by-products (which appear to be slow stabilizers - if they do stabilize at all).

RECORD OF TELEPHONE CONVERSATION
MAY 11, 1995

Carl Bender

Mr. Bender made several suggestions for editorial changes in the record of the meeting at MSI on May 4, 1995. (These have been made and will appear as changed in the Third Quarterly Report on Phase One.)

MSI stands ready to review the revisions to the test plan and the draft of the Continuation Application when drafts of each are available.

Mr. Bender will send a set of observations of the laboratory treatabilities within a few days. These can be placed in the Continuation Application and the Third Quarterly Report.

RECORD OF MEETING
MAY 17, 1995
1139 BENEDUM HALL

Present: James Cobb, Ronald Neufeld, Emanuel Schreiber, Vourneen Clifford and Jana Agostini

Continuation Application

Dr. Cobb is beginning to write the technical portion and Ms. Bazaz will prepare the required forms. It was suggested that the difference between stabilization and solidification be emphasized.

Laboratory Work

Ms. Clifford will soon have the four additional metals analyzed for all 45 of the TCLP extracts of the treatment samples. She will send them to Mr. Bender as soon as they are all available for his final evaluation of treatability.

Database

Ms. Agostini, the summer undergraduate hire from Pitt, is conversant in EXCEL and expects to learn Quatropro very quickly. She will take charge of setting up the database fully. The use of Quatropro vs. EXCEL was discussed. Quatropro is closely linked to WordPerfect, while EXCEL is associated with Microsoft Windows. Our group is using Quatropro because the faculty in the group word process using WordPerfect.

Solidification Studies

It would appear at this point that the first solidification studies should use a 1:9::CONSOL by-product:waste ratio, based upon the stabilization of lead, to make concrete (3" by 6" cylinders, 1 ½ to 2" slump). The next solidification studies should use the EPC and Tidd by-products to make soil-like compactions. The ratios of by-product to waste will need to be explored further because so few fast stabilizations were effected.

Effect of Phosphate Ion

Considerable discussion was given to possible explorations of adding phosphate ion to the by-product/waste blends. Dr. Schreiber will investigate different sources of phosphate ion and Prof. Neufeld will devise experimental approaches to studying the effect of the phosphate ion.

Research Activities for the REU Student

The summer undergraduate student for the project from the Chemical & Petroleum Engineering Department's Research Experience for Undergraduates Program, sponsored by the National Science Foundation, will begin work on June 1, 1995 for ten weeks. Possible projects were suggested:

- Growth studies of crystals, using the scanning electron microscope, and examining the effect of the phosphate ion.

- Exploring the effect of including sewage sludge incinerator ash (from ALCOSAN) or blends of wood ash and coal ash (from a wood/coal co-fired unit) on stabilization and solidification of metal-laden hazardous wastes.

- Stabilization and solidification of sewage sludge incinerator ash using the CCT by-products.